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# ECG Tools for Cancer Screening

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**Abstract**: Various cancers can be screened quickly by detection of visible and invisible abnormal findings appearing at ECGs. Data were statistically processed using variation and regression analyses. Evaluation of statistical reliability for the groups studied was made according to the p-value for the meaning of chi-square, and differences were considered significant at $p<0.05$. In the group was included 31 individuals without cancer and 67 persons with different types of cancer. p- wave may be use with an insignificantly degree of probability as a predictor of cancer for women. QRS complex may be used as an additional indicator of cancer for men. Dividing the groups by sex showed the presence of statistically significant difference between the mathematical expectations for the groups. The results showed that obtained logistic regression model possessed good abilities for cancer prediction among men, based on the ECG.

**Keywords:** ECG, Tools, Cancer, Screening, Prediction

## Introduction

New tools for cancer screening covers a broad spectrum of innovations including optical sensors, nanotechnology, affinity agents, imaging contrast agents, nanofluidics and cell-based assays. Detection of cancers by non-invasive methods such as X-Ray, CT scan, and MRI & PET scan are non-invasive and quick but very expensive. The following are examples of non-invasive quick method of diagnosis and treatment of cancers using different approaches:

- Soft red laser beam scanning of different parts of body;
- By speaking voice;
- Using strong electromagnetic field resonance phenomenon between 2 identical molecules or tissues, known as O-Ring Test, for which US patent was given, we can identify any molecules non-invasively. Using this method, we are able to map accurate organ representation areas at different parts of the body surfaces.

### Objectives

Objectives of this study are to develop new non-invasive, safe, quick and economical method of detecting cancers by ECGs.

## Method

Data were statistically processed using variation and regression analyses. Evaluation of statistical reliability for the groups studied was made according to the p-value for the meaning of chi-square, and differences were considered significant at $p<0.05$.

### ANOVA Analysis



- Selection and peer-review under responsibility of the Organizing Committee of the Conference

ANOVA analysis was made of different factors through dividing all persons investigated into groups. The participants were divided into four groups: group 1
– males who had cancer, group 2 – males without cancer, group 3 – females who had cancer, and group 4 – females without cancer.

**Logistic Regression Analysis**

Regression analysis is applied to describe the dependence between one dependent variable and one or more independent variables. The odds ratio is used as a measure for the degree of dependence between risk factors and cancer. Logistic regression analysis may help to find the most appropriate and cost- effective, as well as the most acceptable model, which can describe the relationship between the outcome of a disease and a multitude of independent variables (factors).

**Participants**

In the group was included 31 individuals without cancer and 67 persons with different types of cancer from Northwest Bulgaria (Table 1).

Table 1. Individuals with cancer

| № | Diagnosis | men | women |
|---|---|---|---|
| 1. | Colon cancer | 5 | 2 |
| 2. | Hypopharyngeal cancer | 1 | - |
| 3. | Pancreatic cancer | 2 | 2 |
| 4. | Lung cancer | 6 | 3 |
| 5. | Rectal cancer | 6 | 1 |
| 6. | Kydney cancer | 1 | - |
| 7. | Sigma cancer | 3 | 1 |
| 8. | Stomach cancer | 1 | - |
| 9. | Bladder cancer | 1 | - |
| 10. | Prostate cancer | 6 | - |
| № | Diagnosis | men | women |
| 11 | Metastatic cancer | 1 | - |
| 12 | Schloffer-Tumor | 1 | - |
| 13 | Uterine cancer | - | 4 |
| 14 | Endometrial cancer | - | 3 |
| 15 | Breast cancer | - | 8 |
| 16 | Ovarian cancer | - | 5 |
| 17 | Follicular lymphoma (form of non- Hodgkin`s lymphoma) | - | 1 |
| 18 | Mantle cell lymphoma (form of non- Hodgkin`s lymphoma) | - | 1 |
| 19 | Metastatic cancer | - | 1 |
| 20 | Sigma polypus | - | 1 |

A total of 67 patients with cancer were selected from 98 participants. The number of women with cancer was 33 and the number of men was 34. For the study, 67 ECGs of oncology patients, which were collected at the Department of Oncology from July 2017 to April 2018, were provided by Pleven University Hospital(Bulgaria). All data and samples derived from the University Hospital of Pleven were obtained with informed consent under Institutional Review Board. 31 ECGs of patients undergoing surgery without any tumors were collected at the Department of Surgery of Pleven University Hospital.

Heart rate was 77.53/min for oncology patients and 81.24/min for other people in the study.

Systolic (SBP) blood pressure, diastolic (DBP) blood pressure and BMI were measured.
The 67 serum samples of patients with different tumors were evaluated for CBC. We also collected 31 serum samples from 31 patients without cancer as controls in April 2018. The number of women was 17 and the number of men was 14.

Table 2. Basic clinical characteristic of groups

| Characteristic | Individuals with cancer | | Individuals without cancer | |
|---|---|---|---|---|
| | Mean value | SD | Mean value | SD |
| Age | 64 | ±12 | 56 | ±17 |
| DBP [mm Hg] | 74,93 | ±5.87 | 76.13 | ±9.89 |
| SBP [mm Hg] | 122,91 | ±7.13 | 122.74 | ±10.94 |
| Weight [kg] | 72.51 | ±12.91 | 77.42 | ±10.00 |
| BMI [kg/m$^2$] | 25.36 | ±4.27 | 25.05 | ±2.73 |
| HR | 77.43 | ±15.00 | 80.10 | ±18.60 |
| RR [ms] | 801.72 | ±139.89 | 779.71 | ±148.31 |
| PR [ms] | 145.61 | ±21.53 | 142.68 | ±32.67 |
| QRS [ms] | 92.46 | ±23.40 | 95.06 | ±59.32 |
| QT [ms] | 359.01 | ±69.47 | 365.39 | ±33.77 |
| QTc [ms] | 421.30 | ±67.49 | 397.1 | ±94.18 |
| P wave [ms] | 0.22 | ±0.38 | 0.14 | ±0.15 |
| SV1 [mV] | 0.8 | ±0.47 | 0.82 | ±0.35 |
| R wave [mV] | 1.38 | ±0.65 | 1.38 | ±0.57 |
| Er [1012/l] | 4.26 | ±0.71 | 4.69 | ±0.57 |
| Leuc [109/l] | 9.19 | ±4.80 | 9.93 | ±5.76 |
| Hb [g/l] | 119.96 | ±20.91 | 133.83 | ±21.29 |
| Hct [%] | 0.36 | ±0.06 | 0.38 | ±0.08 |
| MCV [fl] | 84.53 | ±11.86 | 83.95 | ±6.73 |
| MCH [pg] | 31.19 | ±24.16 | 31.45 | ±10.71 |
| MCHC [g/dl] | 329.54 | ±11.33 | 328.87 | ±45.00 |
| Plt [109/l] | 273.6 | ±96.92 | 270.72 | ±70.93 |
| Lym [%] | 27.01 | ±11.96 | 23.74 | ±9.63 |
| Mo [%] | 8.03 | ±3.60 | 7.89 | ±10.05 |
| Gran [%] | 65.29 | ±13.6 | 66.82 | ±15.08 |
| RDW [%] | 17.60 | ±2.32 | 16.3 | ±10.24 |

The following CBC parameters were analyzed: red blood cell count (RBC), hemoglobin (Hb), hematocrit (Hct), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), red blood cell distribution width (RDW), platelet count (PLT), mean white blood cell count (WBC), and leukocyte differential count.

One way ANOVA test was performed on ECGs by splitting the participants into four groups:
1) men with cancer;
2) men without cancer;
3) women with cancer;
4) women without cancer.

Multiple comparison test of means was used to obtain the differences between every two groups. Multiple logistic regression analysis was implemented to estimate OR of cancer.

## Results and Discussion

### Results from ANOVA Analysis

ANOVA analysis of heart rate (HR) was made. The diagram of quartiles of heart rate in males and females is shown on Figure 2. The biggest difference identified was that between the medians in the men with and men without cancer.

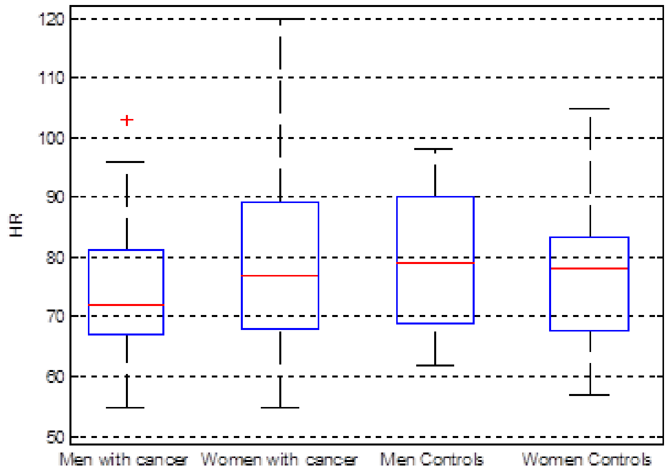


Figure. 1. Diagram of quartiles of HR in male and female groups

Table 3. Data from ANOVA analysis of HR by sex.

| Deviations | Sum of squares | Degrees of freedom | Mean value | F – test statistic | p-value |
|---|---|---|---|---|---|
| Between groups | 1370.877 | 3.000 | 456.959 | 1.789 | 0.155 |
| Within groups | 24006.684 | 94.000 | 255.390 | | |
| Total | 25377.561 | 97.000 | | | |

Table 4. Data from multiple component analysis for HR by sex.

| Group one | Group two | Lower bound of CI | Difference between ME | Upper bound of CI |
|---|---|---|---|---|
| Men with cancer | Men controls | -23.652 | -10.378 | 2.895 |
| Women with cancer | Women controls | -8.135 | 4.344 | 16.823 |

Multiple component analysis of PR interval showed that the differences were not significant and it could be assumed, with a high probability, that there is no connection between PR interval and cancer (Table 5, Table 6)

Table 5. Data from ANOVA analysis of PR by sex

| Deviations | Sum of squares | Degrees of freedom | Mean value | F – test statistic | p-value |
|---|---|---|---|---|---|
| Between groups | 2077.947 | 3.000 | 692.647 | 1.072 | 0.365 |
| Within groups | 60719.247 | 94.000 | 645.949 | | |
| Total | 62797.194 | 97.000 | | | |

Table 6. Data from multiple component analysis for PR interval by sex.

| Group one | Group two | Lower bound of CI [ms] | Difference between ME [ms] | Upper bound of CI [ms] |
|---|---|---|---|---|
| Men with cancer | Men controls | -27.01 | -5.90 | 15.21 |
| Women with cancer | Women controls | -9.59 | 10.26 | 30.11 |

ANOVA analysis of p-wave was made. The multiple component analysis performed showed that the difference between the mean values in the two groups (women with cancer and women without cancer) was 0.137 [ms] with a confidence interval -0.124÷0.397 [ms]. These results confirm that the differences were significant for women. Consequently, p- wave may be use with an insignificantly degree of probability as a predictor of cancer for women (Table 7, Table 8).

Table 7. Data from ANOVA analysis of p-wave by sex

| Deviations | Sum of squares | Degrees of freedom | Mean value | F – test statistic | p-value |
|---|---|---|---|---|---|
| Between groups | 0.557 | 3.000 | 0.186 | 1.753 | 0.162 |
| Within groups | 9.319 | 88.000 | 0.106 | | |
| Total | 9.876 | 91.000 | | | |

Table 8. Data from multiple component analysis for p-wave by sex

| Group one | Group two | Lower bound of CI [ms] | Difference between ME [ms] | Upper bound of CI [ms] |
|---|---|---|---|---|
| Men with cancer | Men controls | -0.263 | 0.025 | 0.314 |
| Women with cancer | Women controls | -0.124 | 0.137 | 0.397 |

ANOVA analysis of QRS complex was made. The value of F-statistic and p- value proved statistically significant differences. The multiple component analysis performed demonstrate that the differences between males and females were bigger than were those between persons with cancer and healthy persons. Results showed that the difference between the mean values in the two groups (men with cancer and men without cancer) was bigger than the difference between the mean values in the two groups (women with cancer and women without cancer) was bigger than. Despite of this, QRS complex may be used as an additional indicator of cancer for men (Table 9, Table 10)

Table 9. Data from ANOVA analysis of QRS by sex

| Deviations | Sum of squares | Degrees of freedom | Mean value | F – test statistic | p-value |
|---|---|---|---|---|---|
| Between groups | 3644.794 | 3.000 | 1214.931 | 2.900 | 0.039 |
| Within groups | 39245.665 | 94.000 | 417.507 | | |
| Total | 42890.459 | 97.000 | | | |

Table 10. Data from multiple component analysis for QRS complex by sex.

| Group one | Group two | Lower bound of CI [ms] | Difference between ME [ms] | Upper bound of CI [ms] |
|---|---|---|---|---|
| Men with cancer | Men controls | -4.673 | 12.298 | 29.270 |
| Men with cancer | Women controls | 0.036 | 15.912 | 31.787 |
| Women with cancer | Women controls | -10.151 | 5.804 | 21.759 |

Is done ANOVA analysis of QT interval after dividing the persons into groups – men with cancer and men without cancer, women with cancer and women without cancer. The values obtained with the multiple component analysis are shown on Table 11 and Table 12. The data showed that after dividing the persons investigated into groups by sex, there was a statistically significant difference between the mathematical expectations for the groups.

Table 11. Data from ANOVA analysis of QT interval by sex.

| Deviations | Sum of squares | Degrees of freedom | Mean value | F – test statistic | p-value |
|---|---|---|---|---|---|
| Between groups | 34885.729 | 3.000 | 11628.57 | 3.430 | 0.020 |
| Within groups | 318671.179 | 94.000 | 3390.119 | | |
| Total | 353556.90 | 97.000 | | | |

Table 12. Data from multiple component analysis for QT interval by sex

| Group one | Group two | Lower bound of CI [ms] | Difference between ME [ms] | Upper bound of CI [ms] |
|---|---|---|---|---|
| Men with cancer | Men controls | -20.260 | 28.101 | 76.456 |
| Women with cancer | Women controls | -84.469 | -39.004 | 6.462 |

ANOVA analysis of QTc was made. There was a difference in the values of medians in groups with cancer and those of individuals without cancer, and this difference was found greater for the male groups. The numerical indices from ANOVA are shown on Table 13.

Table 13. Data from ANOVA analysis of QTc by sex.

| Deviations | Sum of squares | Degrees of freedom | Mean value | F – test statistic | p-value |
|---|---|---|---|---|---|
| Between groups | 58913.617 | 3.000 | 19637.872 | 3.548 | 0.017 |
| Within groups | 520225.249 | 94.000 | 5534.311 | | |
| Total | 579138.866 | 97.000 | | | |

Dividing the groups by sex showed the presence of statistically significant difference between the mathematical expectations for the groups. The results obtained by multiple component analysis are shown on Table 14.

Table 14. Data from multiple component analysis for QTc interval by sex.

| Group one | Group two | Lower bound of CI [ms] | Difference between ME [ms] | Upper bound of CI [ms] |
|---|---|---|---|---|
| Men with cancer | Men controls | 12.130 | 73.920 | 135.710 |
| Women with cancer | Women controls | -78.053 | -19.963 | 38.128 |

There was overlapping of quartiles from 25% to 75% for both groups, which showed that the difference between the medians of the two groups was statistically insignificant. The analysis of the results proved that for the group investigated heart rate, RR interval, SV1, and R wave were not a marker for cancer. The QRS complex may be used as a predictor for cancer in the males. The p- wave may be used with an insignificantly degree of probability as a predictor of cancer for women. The most significant ECGs indicators for cancer identified were QT interval and QTc interval. This is why a more extensive research of the ECGs tools for cancer screening is necessary.

### Results from Regression Analysis

To assess the combined influence of parameters, logistic regression models with three factors included was performed. The first model included QRS, QT and QTc. This model was presented as follows:

$$\ln\left(\frac{P}{1-P}\right) = b_0 + b_1 * QRS + b_2 * QT + b_3 * QTc$$

where P is the probability for occurrence of cancer and $b_0$, $b_1$, $b_2$, and $b_3$ are the coefficients of the logistic regression. Coefficients of regression were found for males and females. The p value of overall model fit for women was $p=0.4480$ and for men was $p<0.0009$. Results showed that there was statistical significance of model only for men. The values of regression coefficients was $b_0=-24.8901$, $b_1=0.0429$, $b_2=0.0371$ and $b_3=-0.0206$. On the basis of obtained coefficients it was calculated how the odds ratio (OR) for cancer increased if the respective parameter increased with 5% of mean value. When the QRS increased with 5% of mean value OR for cancer increased 1.22 times. When the QT increased with 5% of mean value OR for cancer increased. 2.01 times. When the QTc increased with 5% of mean value OR for cancer increased 1.55 times.

A threshold of OR is used for assessment of cancer presence among men. The probability of cancer detection (PD) was evaluated as a ratio between the number of men with cancer for which the OR is above threshold and the number of all men with cancer. The probability of false alarm (PFA) that a man without cancer was assessed as a man with cancer was evaluated as a ratio between the number of men without cancer for which the OR is above threshold and the number of all men without cancer. The probabilities of cancer detection and false alarm as functions of threshold are shown on Figure 2.

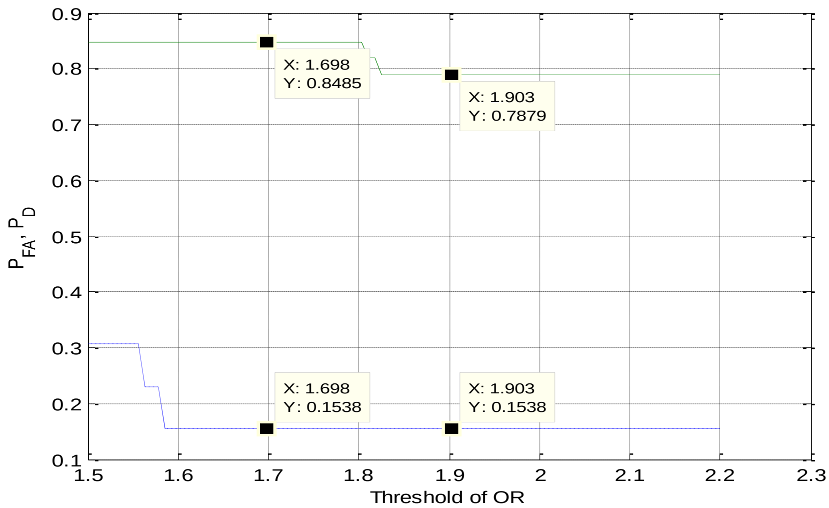


Figure 2. The probabilities of cancer detection and false alarm

If the threshold of OR was chosen 1.7 then the probability of cancer detection was 84.85% and the probability of false alarm was 15.38%. If the threshold of OR was chosen 1.9 then the probability of cancer detection was 78.79% and the probability of false alarm was 15.38%.

## Conclusion

The results showed that obtained logistic regression model possessed good abilities for cancer prediction among men, based on the ECGs. Studies proved that further researches for relation between cancer and ECGs will be useful for early cancer screening.

## Scientific Ethics Declaration

The author declares that the scientific ethical and legal responsibility of this article published in EPHELS journal belongs to the author.

## Acknowledgements or Notes

* This article was presented as an oral presentation at the International Conference on Medical and Health Sciences (www.icmehes.net) held in Antalya/Turkey on November 16-19, 2023.

*Please provide acknowledgements or notes in a separate section at the end of the article before the references.

## References

Berson, A.S., Pipberger H.V., (1965), Errors caused by inadequacy of low-frequency response of electrocardiographs. *Digest of 6th International Conference on Biomedical Engineering, Tokyo, Japan, Society of Med Electr Biomed Eng*, (*pp*.13–14). Tokyo*: Okomura Printing Co.*

Daskalov I.K., Dotsinsky I. A., Christov I.I., (1998), Developments in ECG acquisition, preprocessing, parameter measurement and recording. *IEEE Eng in Med and Biol Magazine*, *17*,50–58.

Dotsinky, I. (2007). *Review of advanced methods and tools for ECG data analysis*. D.G. Clifford, (F. Azuaje & P. E. McSharry (Eds.),Boston,London:

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