# Analysis of Blood Pressure Pattern for Early Prophylactic Diagnosis of Cardiac Disorder

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**Abstract:** The blood pressure of brachial artery on left arm of the patient can be referred to the diagnosis of disorder of cardiac function. An assessment model correlates variance rate of cardiac cycle to the cardiac disorder is proposed. The regression analysis reveals the accuracy of the analysis of blood pressure pattern for early prophylactic diagnosis of cardiac disorder.

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**Keywords:** assessment model, causal analysis, cardiac disorder

## Introduction

Due to ventricular diastolic dysfunction, atrial enlargement and left ventricular hypertrophy, most cardiac disorder may cause the symptom manifested by arrhythmia **[1]**. Several noninvasive methods were developed to get the early prophylactic diagnosis of cardiac disorder **[2].** The aim of this study is to provide an assessment of the early prophylactic diagnosis of cardiac disorder through relationship analysis between blood pressure patterns (BPP) and ECG.

The analysis of BPP is based upon the blood supply in a cardiac cycle. Due to the abnormal blood supply, no pain and no specific sign of arrhythmia for attention, life threatening complications such as cardiac infraction, shock, and sudden death just kill people in a minute. Under normal circumstances, the left ventricle of the heart can be instantaneous relaxed after each contraction so that the blood from the pulmonary vein can quickly fill into the ventricle, that is, the relaxation and filling of the diastolic heart. Meanwhile, rapid intense contraction may promote a large number of bloods into the aorta to transport to the arteries of the body, which is the systolic contraction and efflux of the heart **[3]**. Generally, detection of cardiac disorder can be revealed by ECG, echocardiography ultrasound and Cardiac catheterization exams etc. **[4]**. Instruments for the detection are not only expensive but also complicated to use for the staff. In order to address these deficiencies, we have developed a simple analytic method of BPP for early prophylactic diagnosis of cardiac disorder to reduce the mortality **[5]**. In this study, the primary object is to provide a method for BPP analysis by measuring a time series signal of blood pressures that reflects the functions of cardiac valves correlated with the blood flow in heart. The measured blood pressures variations can correspond to the presence of abnormal blood flow and cardiovascular disease **[6]**.

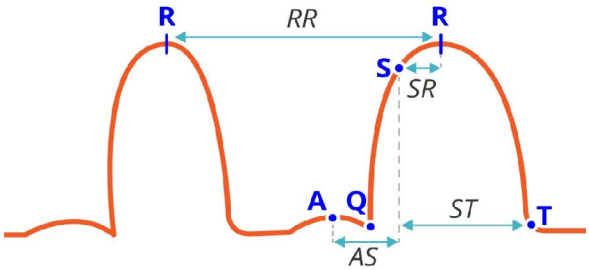


**Figure 1** Definition of BPP parameters
(Permission of reprint from ecardiac by ESTI HR Institute)

From Table 2, regression equation is presented as RR_V = 0.018*(0.074RR-49). We can easily check the RR_V to realize how risk the patient is in the early state of sinus rhythm with ST-T wave being abnormal assessed from ECG spectrum **[7]**. When the cardiac disorder contains any factor that affects the disease state of sinus rhythm with ST (ECG variable) interval abnormality, the RR can be reveal in an early time if the BPP analysis is available. Meanwhile, we found the assessment is close to 80 percent (0.796) accurate in clinical experiments.

**Table 1:** BPP Data sheet and disease state of ECG interpretation for the subjects

| id | RR | RR_V(%) | AS | ST | SR | | Disease state |
|---|---|---|---|---|---|---|---|
| 185 | 733 | 2 | 122 | 264 | 29 | 1 | Sinus rhythm with QRS low voltage |
| 187 | 511 | 3 | 85 | 167 | 37 | 0 | Normal |
| 189 | 772 | 7 | 129 | 267 | 42 | 2 | Sinus rhythm with T abnormal |
| 190 | 683 | 3 | 114 | 244 | 29 | 2 | Sinus rhythm with ST-T anomaly |
| 197 | 872 | 2 | 145 | 319 | 30 | 2 | Sinus rhythm with ST-T anomaly |
| 199 | 706 | 3 | 118 | 248 | 34 | 2 | Sinus rhythm with ST-T anomaly |
| 202 | 706 | 4 | 118 | 252 | 30 | 1 | Sinus rhythm with right axis deviation of QRS |
| 206 | 850 | 3 | 142 | 307 | 33 | 3 | Sinus rhythm; V1, V2 lead R/S |
| 217 | 856 | 2 | 143 | 314 | 29 | 2 | Sinus rhythm with ST-T anomaly |
| 220 | 1061 | 33 | 177 | 381 | 43 | 2 | Sinus rhythm with ST-T anomaly |
| 489 | 722 | 4 | 120 | 268 | 21 | 0 | Normal |
| 490 | 717 | 3 | 119 | 279 | 7 | 2 | Sinus rhythm with ST-T anomaly |
| 491 | 817 | 16 | 136 | 279 | 48 | 1 | Sinus rhythm |
| 492 | 661 | 3 | 110 | 232 | 32 | 0 | Normal |
| 493 | 950 | 35 | 158 | 365 | 15 | 2 | Sinus rhythm with ST-T anomaly |
| 494 | 844 | 2 | 141 | 282 | 56 | 0 | Normal |
| 495 | 956 | 21 | 159 | 350 | 32 | 3 | Sinus rhythm with q wave |
| 496 | 817 | 3 | 136 | 308 | 19 | 3 | Sinus rhythm with atrial premature beats |
| 497 | 600 | 3 | 100 | 214 | 26 | 1 | Sinus rhythm with left axis deviation of QRS |
| 499 | 689 | 2 | 115 | 260 | 15 | 2 | Sinus rhythm with ST-T anomaly |
| 500 | 539 | 47 | 90 | 174 | 42 | 3 | Sinus rhythm with q wave |
| 501 | 622 | 18 | 104 | 234 | 15 | 1 | Sinus rhythm with ST-T anomaly |
| 502 | 611 | 3 | 102 | 217 | 28 | 3 | Sinus rhythm with ST-T anomaly |
| 503 | 994 | 10 | 166 | 376 | 22 | 3 | Sinus rhythm with atrial premature beats |
| 504 | 606 | 9 | 101 | 208 | 34 | 0 | Normal |
| 505 | 856 | 8 | 143 | 325 | 18 | 0 | Normal |
| 506 | 872 | 4 | 145 | 313 | 36 | 0 | Normal |

**Table 2:** Correlation matrix for the disease state of sinus rhythm with ST (ECG ) abnormality

| parameters | RR | RR_V (%) | AS | ST | SR |
|---|---|---|---|---|---|
| RR | 1.000 | .796 | 1.000 | .978 | .294 |
| RR_V (%) | .796 | 1.000 | .796 | .803 | .120 |
| AS | 1.000 | .796 | 1.000 | .978 | .294 |
| ST | .978 | .803 | .978 | 1.000 | .089 |
| SR | .294 | .120 | .294 | .089 | 1.000 |

**Table 3:** The Assessment Model D2 correlates the predictor RR with dependent variable RR_V

| Model | | R | R square | Adjust R Square | Std. Error | Sig. |
|---|---|---|---|---|---|---|
| D2 | Dependent RR_V% | 0.796 | 0.633 | 0.588 | 8.416 | 0.006 |

| Model | | Unstandardized coefficients | | Standardized coefficients | t | sig |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| D2 | Constant | -49.473 | 16.078 | 0.796 | -3.077 | 0.015 |
| | Predictor: RR | 0.074 | 0.020 | | 3.718 | 0.006 |

**Methods**

In May of 2016, 27 subjects participated into the program being approved by the local Institution Review Board (IRB) in Henan Provincial People's Hospital (in China, Henan Province). Spectrum of the time series signal of the BPP was obtained through the measurement of the pressures of brachial artery on left arm of the subject. Calculating the time intervals between two peaks of the consecutive signals in BPP to obtain the variance of the signal for each cardiovascular blood supply pulse cycle is performed. From **Figure 1**, BPP parameters are defined as that S located two thirds of RQ, A located at the highest point for curve AQ where Q and T are terminal points. Taking the variance of pulse peak, we can find the time intervals for each signal embedded in each of the cardiac cycle. Under the time variability of each cardiac cycle, compared to ECG, we can determine the early prophylactic cardiac disorder.

**Results**

The parameters of the BPP and ECG are listed in Table 1. The subject was judged in a disease state via ECG interpretation. In Table 2, it shows the correlations of the parameters in disease state of the sinus rhythm with ST (ECG ) wave abnormality. The regression analysis was conducted. The results are shown in Table 3.

**Discussion**

The assessment capability of BPP variable, R-R variability is very sensitive to the states of cardiac disorders. The strength of RR_V (predictor) to predict RR is 80% in assurance with the significance level of P = 0.006. Statistically, through causality structure of the variables of ECG and BPP **[8]**, we can assess the states of cardiac disorder for the subjects through the RR_V variable.

**Conclusion**

This study reveals the correlation between brachial artery blood pressure variability and the state of cardiac disorder. We found that R-R variation rate is very susceptible to the cardiac disorder. In BPP analysis, RR_V variability rate is a significant disease parameter. By using of the model that we proposed this model to identify cardiac disorder that can quickly be applied to the general health examination.

Although using of brachial artery BPP as indicators for the assessment of heart is easy and simple, the early heart and vascular disease related to the relevant parameters of BPP at large-scale population and clinic research has been valued.

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