

# Correlation of Heart Rate Variability and 24-hour Mean Heart Rate with TIMI Risk Score in Acute ST-Segment Elevation Myocardial Infarction

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## Abstract:

**Keywords:**  
TIMI risk score,  
Heart rate  
variability, STEMI.

**Background:** Thrombolysis In Myocardial Infarction (TIMI) risk score, heart rate variability (HRV) and 24hour mean heart rate all are important predictor of prognosis after ST segment elevation myocardial infarction(STEMI). Correlation among these factors has not been studied thoroughly.

**Methods:** This study was conducted in NICVD (National Institute of Cardiovascular Diseases), Dhaka, from July 2008 to June 2009. Total 105 STEMI patients were included in the study. TIMI risk score were calculated and each patient under went 24hour Holter monitoring. SDNN for HRV and mean RR interval for mean heart rate were recorded.

**Results :** Ninety one patients (mean age  $53.9 \pm 10.8$  years), 86.7% were males and 14( mean age  $59.8 \pm 8.8$  years), 13.3% were female. Stratification of subjects by TIMI risk score shows that nearly 60% had risk score in the range of 3 – 7, 17. % between 0 – 2 and 24% 8 or more than 8. SDNN and RR interval stratified by TIMI risk score demonstrates that both the variables decreases significantly with the increase of TIMI risk score. Among the TIMI risk groups SDNN values were  $120.0 \pm 19$ ,  $871.0 \pm 20.5$  and  $40.9 \pm 6.4$  msec in mild, moderate and high risk group respectively( $p < 0.001$ ). Mean RR were  $836.8 \pm 121.0$ ,  $776.7 \pm 130.3$  and  $649.7 \pm 75.5$  msec in low, intermediate and high risk group respectively( $p < 0.001$ ). There was a significant correlation between depressed SDNN and high TIMI risk score ( $r = .893$ ,  $p = .001$ ). High TIMI risk score also showed a negative correlation with mean RR interval ( $r = -.574$ ,  $p < 0.001$ ). Mean RR and SDNN show a perfect linear relationship ( $r = 0.657$ ,  $p < 0.001$ ).

**Conclusion:** It was observed that depressed heart rate variability and increased 24-hours mean heart rate correlates with high TIMI risk score after acute ST-elevation myocardial infarction.

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## Introduction:

Acute ST- elevated myocardial infarction (STEMI) is a major component of acute coronary syndrome and is associated with significant mortality and morbidity.<sup>1</sup> Three small scale population based studies showed average prevalence of ischaemic heart disease 6.5 per thousand population of Bangladesh.<sup>2</sup>

Individual patient reflects a combination of clinical features that influence prognosis and these factors must be appropriately weighted to produce an accurate assessment of risk.<sup>3</sup> Even among patients with STEMI for whom initial therapeutic options are well defined, patient risk characteristics impact short and

long term medical decision making.<sup>4</sup> The Thrombolysis In Myocardial Infarction (TIMI) risk score for STEMI provides a convenient mechanism to identify baseline differences in risk profile and offers a framework for analysis stratified by risk group at presentation.<sup>5</sup> The predictive value of depressed heart rate variability after myocardial infarction has been shown to be independent of other risk factors such as left ventricular ejection fraction (LVEF).<sup>6</sup> The standard deviation of all RR intervals during 24 hours (SDNN) is by far the most common estimate of heart rate variability, and it is established as a scientifically important prognostic factor after AMI.<sup>7</sup> Predischarge 24-

hour mean heart rate is a strong predictor of mortality after myocardial infarction that can compete with LVEF and HRV.<sup>6</sup>

Thus TIMI risk score involves multiple parameters and applicable during the initial evaluation of patients. HRV study is noninvasive, safe. Analysis is computer based has good reproducibility up to several months of acute MI.<sup>8</sup>

TIMI risks core, HRV and 24-hour mean heart rate all are independent predictor of future cardiovascular events after AMI. A very few study were done to evaluate these risk factors in our country.

### Materials and methods:

This cross sectional study was conducted in NICVD (National Institute of Cardiovascular Diseases), Dhaka, from July 2008 to June 2009. Informed written consent was taken from every patient or near relatives. Total 105 patients of acute STEMI were included in the study. Patients with atrial fibrillation, bundle branch block or significant noncardiac illness were excluded from the study. Out of all daily admitted patients one was taken by lottery method for final inclusion in the study.

TIMI risk score for STEMI was calculated for all patients at the time of entry in to the study considering following clinical parameters age, body weight, history of diabetes mellitus/hypertension/angina, pulse, blood pressure, Killip class of heart failure, surface of MI, duration of symptom onset to thrombolysis.<sup>5</sup>

Subjects were divided in to three groups, 0-2 low risk, 3-7 intermediate risk and  $\geq 8$  as high risk group according TIMI risk score.<sup>9</sup>

Holter monitoring for 24- hour was done for all patients in the in hospital period. Data were recorded by a recorder of dms 300-7 containing compact flash card-Sandisk (64MB). The recorder was driven by single 1.5 volt AA size alkaline battery. It was attached to the seven chest lead positioned according to the mentioned colour code. All medications were continued during the recording.

Holter data were analyzed by computerized analysis method using Victor Bravo Inc.(Prmium-10) DSM, Nevada, USA system. Premature beats

with artifacts were removed manually. Remaining data were taken as printed output. Standard deviation of the all normal to normal RR interval ie SDNN in msec. for HRV and Mean R-R interval in msec for heart rate were recorded for each patient.

SDNN <50msec is considered high risk and 50-100 msec. is considered as intermediate and SDNN >100 considered as low risk group.<sup>8</sup>

### Statistical Analysis:

All data were analyzed by using computer based SPSS (statistical programme for social science) programme. Continuous data were expressed as median or mean  $\pm$  SD. Dichotomous data was expressed as percentage. Comparison among the groups was done by unpaired t-test or ANOVA which one is applicable. The correlation test was done to find the correlation of the variables. p-value < 0.05 was considered as significant.

### Observation and Results:

Out of 105 study subjects, 91(86.7%) were males and the rest 14(12.3%) females giving a male to female ratio of roughly 7:1. Distribution of subjects by types of MI shows that nearly 70% had anterior MI and 24.7% had inferior MI. Very few subjects had RVI + inferior MI and other types of MI (each 2.9%) Killip class of heart failure demonstrates that 65% of the subjects was classified as Class-1 and the rest 35% Class-II. None of the subjects exhibited Class-III and Class-IV failure Out of 105 study subjects 103 got Streptokinase therapy. Over 70% of the patients received treatment with streptokinase after lapse 4 or more than 4 hours of time from symptom onset. The mean time lapsed between symptom onset and start of treatment with streptokinase was 5.7 hours. Risk factor distribution shows that over 50% of the subjects had hypertension, nearly 50% had smoking habit 28.6% diabetes, 12.4% family history of ischemic heart diseases, and 7.6% dyslipidaemia (Table-I)

Analysis of influence of certain biological and clinical factors on SDNN shows that diabetic MI patients had significantly depressed SDNN than that of their non-diabetic counterpart (p = 0.001). Older subjects (60 years or more) and patients of anterior MI had also depressed SDNN than the relatively less older subjects and patients with inferior MI, although the differences did not reach the level of significance (Table II).

**Table-I**  
*Baseline clinical characteristics of study population(n=105)*

Parameters	
Male	91(87%)
Female	14(14%)
Age	
Male	53.9 ± 10.8 years
Female	59.8 ± 8.8 years.
Types of MI	
Anterior	70%
Inferior	25%
Inf.+RVI	3%
Killip class	2%
I	68(65%)
II	37(35%)
Duration between symptom onset to thrombolysis	
<4 hours	30(29%)
>4 hours	73(71%)
Risk factors	
Smoking	52(49.5%)
Hypertension	53(50.6%)
DM	30(28.6%)
Family history of IHD	13(12.4%)
Dyslipidemia	8(7.6%)

Age < 60 and anterior MI were found significantly prone to develop lower mean RR interval (p = 0.003 and p = 0.009 respectively). Diabetic MI patients exhibited a much lower mean RR interval than their non-diabetic fellows, though the difference did not turn to significant (p = 0.100) (Table III).

**Table-II**  
*Influence of age, diabetes and types of MI on SDNN (n = 105)*

Risk factors	SDNN (msec)	
	Mean ± SD	P value
Age		
<60 years	75.5 ± 26.9	0.389
>60 years	70.3 ± 32.9	
Diabetes mellitus		
Diabetic	59.5 ± 20.5	0.001
Non-diabetic	77.3 ± 32.9	
Types of MI		0.143
Anterior	69.3 ± 33.1	
Inferior	78.9 ± 24.1	

Data were analysed using Student's t-Test and were presented as mean ± SD.

Correlation between TIMI score and SDNN shows that the two variables exhibit a significantly negative correlation (r = -0.893, p < 0.001) (Fig. I).

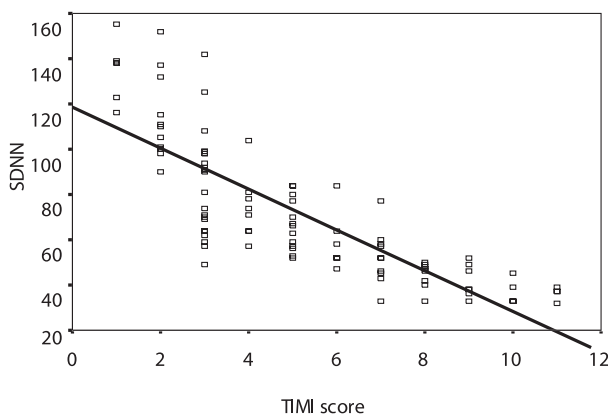
Correlation between TIMI score and mean RR interval demonstrates that the two variables bear a significantly negative correlation (r = -0.574, p < 0.001) (Fig. II). SDNN and RR interval stratified by TIMI risk score demonstrates that both the variables decreases significantly with the increase of TIMI risk score In the low risk group (TIMI 0-2) mean SDNN is 120.0 ± 19.8, in intermediate risk group(TIMI 3-7) it is 71.0 ± 20.5 and in high risk group(TIMI e"8) SDNN is 40.9 ± 6.4 msec. Similarly mean RR interval is 836.8 ± 121.0 msec in low risk group, 776.7 ± 130.3 msec in intermediate risk group and 649.7 ± 75.5 msec in high risk group(p < 0.001) (Table IV).

Correlation between mean RR and SDNN shows the two variables bear a perfect linear relationship (r = 0.657, p < 0.001) (Fig.-3).

**Table-III**  
*Influence of age, diabetes and types of MI on mean RR interval*

Risk factors	Mean RR interval (m sec)	
	Mean ± SD	p-value
Age (years)		
< 60	728.3 ± 116.5	0.003
≥ 60	807.0 ± 147.4	
Diabetes mellitus		
Diabetic	722.9 ± 111.2	0.100
Non-diabetic	770.3 ± 139.6	
Types of MI		
Anterior	734.6 ± 128.4	0.009
Inferior	807.4 ± 132.5	

Data were analysed using Student's t-Test and were presented as mean ± SD.

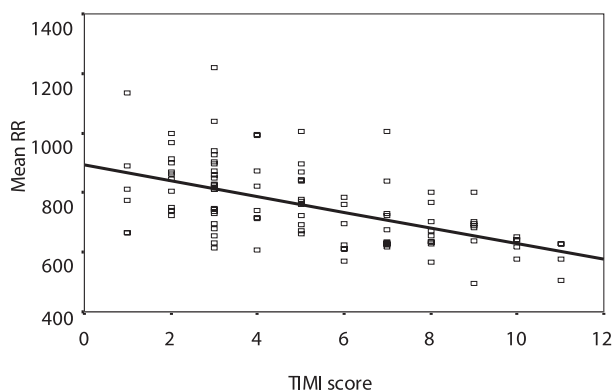


**Fig.-1: Correlation between TIMI score and SDNN**

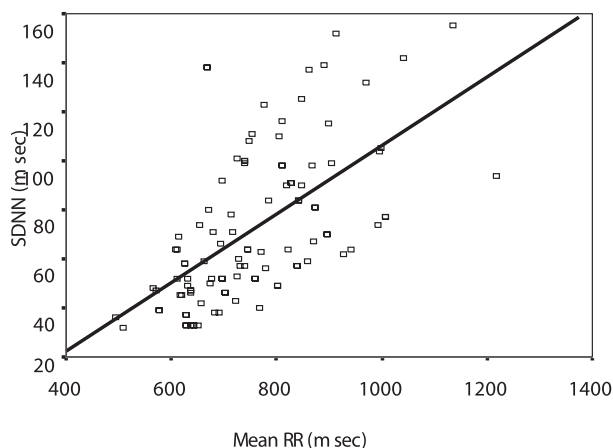
**Table-IV**  
SDNN and RR interval stratified by TIMI risk score

SDNN and RR interval	TIMI score			p-value
	0 – 2	3 – 7	≥ 8	
SDNN	120.0 ± 19.8	71.0 ± 20.5	40.9 ± 6.4	< 0.001
RR interval	836.8 ± 121.0	776.7 ± 130.3	649.7 ± 75.5	< 0.001

Data were analysed using ANOVA statistics and were presented as mean ± SD.



**Fig.-2:** Correlation between TIMI score and mean RR interval



**Fig.-3:** Correlation between mean RR interval and SDNN

### Discussion :

Heart rate variability (SDNN), 24 hours mean heart rate (RR interval) and TIMI risk score after acute STEMI were evaluated. Special emphasis was given to relationship of TIMI risk score with SDNN and RR interval. Factors affecting SDNN and RR interval were also evaluated.

In this study heart rate variability (SDNN) was found significantly depressed in diabetic patients than nondiabetic patients, which is consistent with the study of Ewing *et al.*<sup>10</sup> as Parasympathetic damage occurs more commonly than sympathetic damage in diabetic autonomic neuropathy. This observation is not consistent with the finding of Mohosin.<sup>11</sup>

Present study showed that SDNN values are low in elderly (e"60years) age group than younger (<60 years) age group. Though it did not reach the level of significance this finding is consistent with the observation of Singh H *et al*<sup>13</sup> who showed depressed HRV trend in elderly people. Mohosin<sup>11</sup> observed similar finding from NICVD. Failure to become statistically significant may be due to small sample size and relatively few subjects over 60 years age group.

In this study HRV (SDNN) was more depressed in anterior MI group than in inferior MI group. Though the difference was not statistically significant and this is against the observation of Mohosin.<sup>11</sup> Abildstorm *et al*<sup>7</sup> proposed that relationship of HRV with site of MI is not constant. It may be changed with the duration of onset of MI to the recording of holter.

Mean heart rate (RR interval) was significantly higher in anterior MI than inferior MI in this study. This finding is corroborated by the observation of Mohosin.<sup>11</sup> Mallani *et al*<sup>12</sup> proposed that anterior ischemia may stimulate sympathetic afferent nerve and increases sympathetic tone.

Present study showed that mean heart rate was also significantly lower in older (e"60 years) age group than relatively younger (<60 years) age group. This finding is consistent with the data of Sing H *et al.*<sup>13</sup> It is due to the reduced sympathetic tone associated with aging.



In diabetic subjects mean heart rate is higher than nondiabetic subjects in this study. But the values did not reach in the level of significance ( $p=0.100$ ).

In present study SDNN and RR interval stratified by TIMI risk score demonstrated that both the variables decreased significantly with the increase of TIMI risk score. In the low risk group (TIMI 0-2) mean SDNN is  $120.0 \pm 19.8$ , in intermediate risk group (TIMI 3-7) it is  $71.0 \pm 20.5$  and in high risk group (TIMI  $\geq 8$ ) SDNN is  $40.9 \pm 6.4$  msec. So according to TIMI risk score high, intermediate and low risk group correlates with the high intermediate and low risk group according to HRV (High risk SDNN  $< 50$  msec, intermediate risk SDNN  $< 100$  msec and low risk SDNN  $> 100$  msec).<sup>8</sup>

Similarly mean RR interval was  $836.8 \pm 121.0$  msec in low risk group,  $776.7 \pm 130.3$  msec in intermediate risk group and  $649.7 \pm 75.5$  msec in high risk group ( $p < 0.001$ ) in present study. It was also consistent with the finding of Copie X<sup>6</sup> who observed that patients with a mean RR interval  $< 700$  msec are at high risk of mortality after myocardial infarction.

This study showed significant negative correlation ( $r = -0.893$ ,  $p = 0.001$ ) between TIMI risk score and SDNN indicate that increase of TIMI score was associated with depressed heart rate variability.

TIMI risks core also had a negative correlation with 24 hours mean heart rate (RR interval) ( $r = -0.574$ ,  $p < 0.001$ ). That is higher TIMI risk score was associated with higher 24-hour mean heart rate in present study.

Mean RR interval has a perfect linear relationship with SDNN ( $r = 0.657$ ,  $p < 0.001$ ). This finding is consistent with the observation of Mohosin<sup>11</sup>, Copie<sup>6</sup> and Abildstrom.<sup>7</sup>

### Conclusion:

It may be concluded that from the present study it was observed that depressed heart rate variability and increased 24-hour mean heart rate correlate with high TIMI risk score after acute ST-elevation myocardial infarction.

HRV study is noninvasive and safe. Analysis is computer based. So, HRV and 24-hour mean heart rate can be a useful tool for risk stratification of patients after acute STEMI.

Further study can be done to see whether any short term assessment of heart rate can be used for post MI risk stratification.

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