

# HOLTER MONITORING IN CRITICALLY ILL NON-CARDIAC PATIENTS

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### Abstract:

**Introduction:** Holter monitoring is widely used non invasive test to evaluate electrocardiographic abnormalities of patients in a variety of cardiac and non-cardiac diseases. It has been observed that critically ill (cardiac and non-cardiac) patients are at increased risk of arrhythmias, silent ischemia and sudden cardiac death. We want to study the association between critically ill non cardiac patients and cause of sudden cardiac death and chances of developing arrhythmias in such patients.

**Aims and objectives:** To study arrhythmias in critically ill Non-Cardiac patients. ST segment Changes. To study Heart Rate Variability in critically ill Non Cardiac patients.

**Methods :** The total of 45 out of which 30 were male and 15 female ,Critically ill NON-CARDIAC patients above 12 years age such as OP Poisoning, meningitis, intracranial bleed, subdural hematoma, Guillian barre syndrome, hepatic encephalopathy, Etc. admitted in tertiary care institute were selected for Holter monitoring , by using 2.3 Channel, Holter monitor, Forest Medical Systems, LLC, USA.

**Results :** A total of 45 patients were monitored by 24 hours Holter monitoring for arrhythmias, silent ischemia and heart rate variability (HRV) in critically ill non-cardiac patients. Out of 45 patients, 25 were on ventilator. Age more than or equal to 40 years was important risk factor for the development of arrhythmia and ST-T changes. Silent ischemia was present, as documented by Holter monitor in 11 patients, of them, majority were on ventilator. Some form of arrhythmias were presents in majority of patients. Those on ventilator had higher incidence of arrhythmia like ventricular ectopic, supraventricular tachycardia. Ventricular fibrillation was exclusively seen in patient on ventilator. Majority of patients on ventilator had depressed HRV. Depressed heart rate varitability (SDNN<100ms) was associated with development of arrhythmias. During Holter monitoring 4 patients died, all of them died because of cardiac arrhythmia followed by cardiac arrest. One of them was on ventilator and developed silent ischemia followed by Ventricular fibrillation and cardiac arrest.

Keywords: Holter Monitoring, critically ill patients, non-cardiac patients.

### Introduction

What is Holter monitor: A Holter monitor (also called an ambulatory electrocardiography device), named after its inventor, "Dr. Norman J. Holter" is a continuous tape recording of a patient's EKG for 24 hours. Since it can be worn during the patient's regular daily activities, it helps the physician correlate symptoms of dizziness, palpitations (a sensation of

fast or irregular heart rhythm) or black outs. Since the recording covers 24 hours, on a continuous basis, Holter monitoring is much more likely to detect an abnormal heart rhythm when compared to the EKG which lasts less than a minute. It can also help evaluate the patient's ECG during episodes of chest pain, during which time there may be telltale changes to suggest ischemia of the left ventricle.

More than 4 decades of clinical experiences have shown long-term ECG to be one of the most effective non invasive clinical tools in the diagnosis and assessment of cardiac symptoms, prognostic assessment or risk stratification of various cardiac populations and in the evaluation of many cardiac therapeutic interventions. It remains an indispensable and highly refined tool for cardiac rhythm analysis and risk prediction.

However, the value of Holter monitoring in capturing brief symptomatic episodes of conduction system disorders is limited by the fact that they have too occur often enough to be captured during the 24 hour period of recording.

It is a widely used noninvasive test to evaluate electrocardiographic abnormalities of patients in a variety of cardiac and non-cardiac diseases. The clinical utility of the ambulatory ECG recording lies in its ability to continuously examine a patient over an extended period of time, permitting patient ambulatory activity and facilitating the diurnal electrocardiographic examination of patient in a changing milieu (both physiological and psychological) It is a record of past events that permits detailed analysis of dynamic and transient ECG changes. The increased sensitivity of the ambulatory ECG compared with other electrocardiographic test in detecting spontaneous cardiac arrhythmias (which have great inherent variability) has been clearly demonstrated in a variety of clinical trials. Similarly, several studies have shown that, the continuous ambulatory ECG seems ideally suited to studying heart rate variability, which is emerging as an electrocardiographic parameter of diagnostic and prognostic significance.<sup>1-5</sup> In addition, the ambulatory ECG is valuable adjunctive tool in evaluating myocardial ischemia and arrhythmia (overt/silent), by permitting an assessment of ST-segment changes or changes in heart rate that occur during stress (work related or on mechanical ventilation) or spontaneous episode of myocardial ischemia as shown by Kennedy HL, Weins RD, et al.<sup>6</sup> More recently Holter has innovatively been used to examine the amplified high-resolution signal averaged ECG and disclose QT interval change overtime.<sup>7-9</sup>

### **How to prepare for the test?**

The only requirement is that the patient wears loose-fitting clothes. Buttons down the front of the shirt or louse is preferable. This makes it convenient to apply the EKG electrodes, and also comfortably carry the monitor in a

relatively discreet manner

### **How is the test performed ? <sup>10,11</sup>**

The chest is cleaned with an alcohol solution to ensure good attachment of the sticky EKG electrodes. Men with hairy chest may require small areas to be shaved. The EKG electrodes (circular white patches on the left) are applied to the chest. Thin wires are then used to connect the electrodes to a small tape recorder. The tape recorder is secured to the patient's belt or it can be slung over the shoulder and neck with the use of a disposable pouch. The recorder is worn for 24 hours and the patient is encouraged to continue his or her daily activities. To avoid getting the setup wet and damaging the recorder, the patient will not be able to shower for the test. A diary or log is provided so that the patient can record activity (walking the dog, upset at neighbor, etc) and symptoms (skipped heartbeats, chest discomfort, dizziness, etc.) together with the time. The Holter monitor has an internal clock which stamp the time on the EKG strips. These can be used to correlate the heart rhythm with symptoms or complaints. After 24 hours, the Holter monitor needs to be returned to the laboratory. This can be removed by the staff. However, if you live out of town or need to take a shower before leaving the house, the monitor can be disconnected from the electrodes and sent back to the laboratory, together with the completed diary.

### **Indications Of Holter Monitoring <sup>11,12</sup>**

The following ICD-9-CM diagnosis codes have been identified as meeting the criteria for Holter monitoring:

- Acute myocardial infarction
- Paroxysmal Supraventricular Tachycardia
- Post myocardial infarction syndrome
- Cardiac Ischemic Heart Disease
- Mitral valve disorders
- Cardiomyopathy
- Artioventricular Block
- Trifascicular Block
- Lown-Ganong-Levine Syndrome (short P-R)
- Conduction Disorder: Strokes-Adam Syndrome
- Paroxysmal Supraventricular Tachycardia
- Atrial Fibrillation Atrial Flutter
- Ventricular Fibrillation
- Ventricular Flutter

## Cardiac Arrest

Ventricular Premature Beats, contracts/ Systoles

Intermediate coronary syndrome

Sinoatrial Node Dysfunction : Bradycardia / Sick Sinus Syndrome

Rhythm Disorder : Sinus, Nodal, Wand, Pacer cardiac Dysrhythmia,

Transient Alteration of Awareness

Syncope or Collapse

Dizziness / Giddiness : Light-Headed Vertigo

Palpitations: Awareness of Heart Beat

The Holter Monitoring is a continuously evolving discipline in both of its technology and clinical applications. Therefore, the ambulatory ECG, must be evaluated and interpreted with knowledge of the and the limitation of the technical examination used, the duration of examination and the meaning of those data in the specific patient population examined.

The study reviews the technology of Holter monitoring within the context of its current clinical application.

In the study following parameters were analyzed

1. Arrhythmias in critically ill non-cardiac patient
2. Silent ischemia
3. Heart Rate Variability in critically ill non-cardiac patient.

## Aims And Objectives

1. To study arrhythmias in critically ill Non-Cardiac patients.
2. ST segment Changes.
3. To study Heart Rate Variability in critically ill Non-Cardiac patients.

## Material and methods

1. The total of 45 Critically ill NON-CARDIAC patients admitted in tertiary care institute.

2.3 Channel, Holter monitor, Forest Medical Systems, LLC, USA.

## Patient Selection:

Critically ill patients not having any cardiac ailments, above age 12 years of either sex such as OP Poisoning, meningitis, intracranial bleed, subdural hematoma, Guillian barre syndrome, hepatic encephalopathy, Etc.

## Criteria of exclusion

1. Those suffering from major systemic illness such as ischemic heart disease, diabetes, hypertension, as they directly or indirectly related to cardiac ailments.

2. Persons on medication known to affect heart rate/rhythm such as beta-blockers, vasopressors, digitalis, lithium, theophylline, Thyroid hormones, tricyclic antidepressant, verapamil, and other antiarrhythmics Drugs etc.

Subjects satisfying the above inclusion and exclusion criteria were accepted for Holter monitoring and HRV analysis and ST changes. Time domain HRV analysis was performed.

## Methods:

Holter monitoring was performed in Critically-ill patient with or without artificial ventilation for 14 to 24 hours. Holter monitoring is done in 45 patients using 3 channel recorders and analyzed.

Following parameters were obtained for each patient.

1. Significant Arrhythmias
2. Silent Ischemia
3. Heart rate Variability ( By Time Domain Method, with significant levels in HRV indices as SDNN<100ms)

## Results

Holter Monitoring was done in critically ill non cardiac 45 patients (30(66.66%) males and 15(33.33%) females).

## Age:

Out of 45 patients, 26(57.77%) were less than 40 years and

19(42.22%) were more than or equal to 40 years.

Holter monitor was done between 1-16 days of hospitalization.

Total number of deaths : 22(48.88%)  
 Patients on Ventilator : 25(55.55%)  
 Deaths during Holter monitoring : 4

**Table no. 1: Different Abnormalities on Holter**

Different Abnormalities on Holter	No. of Patients (out of 45)	Percentage %
Supra ventricular ectopic	28	62.22
Supraventricular tachycardia	07	15.55
Ventricular ectopic	36	80.00
Ventricular Bigeminy	07	15.55
Ventricular run	07	15.55
Ventricular tachycardia	05	11.11
Ventricular fibrillation	02	04.40
ST displacement	11	24.24

Arrhythmia commonly found in critically ill non-cardiac patients during Holter monitoring were ventricular ectopic 80%, followed by Supra ventricular ectopic 62.22%, least commonly seen was Ventricular fibrillation 04.40%. Evidence of silent ischemia was seen in 24.24% Patients.

**Table No. 2: Arrhythmias And Ventilator**

Arrhythmias	On Ventilator (25)	Without Ventilator (20)	P Value
Supraventricular ectopic	14	14	p>0.05
Supraventricular tachycardia	04	03	
Ventricular ectopic	22	06	p<0.01
Ventricular Bigeminy	05	02	
Ventricular run	07	00	
Ventricular tachycardia	03	02	
Ventricular fibrillation	02	00	

Arrhythmias commonly found in critically ill non-cardiac patients on ventilator were ventricular ectopic 88.85%, followed by SVE 52.00%, least commonly seen was Ventricular fibrillation 8%. There was association between development of ventricular arrhythmias and ventilator (p<0.01). There was no association between development of supraventricular arrhythmias and ventilator (p > 0.05).

Ventricular fibrillation was seen in two patients, both were on artificial ventilation.

Silent ischemia seen in patients on ventilator (32%) was more as compared to patient with out ventilator (15%). However statistical comparison was not possible because of small sample size.

**Table no. 3: arrhythmias and age**

Arrhythmias	Patient <40Yrs	Patient >40yrs	p Value
Ventricular ectopic	15	13	p<0.01
Ventricular Bigeminy	02	05	
Ventricular run	02	05	
Ventricular tachycardia	01	04	
Ventricular fibrillation	00	02	

Arrhythmias in critically ill non cardiac patients was more commonly observed in patients with age more than or equal to 40 years. There was significant association between development of ventricular arrhythmia and age more than or equal to 40 years in critically ill non-cardiac patient (p<0.01)

**Table No 4 : Arrhythmias, Age And Ventilator**

Arrhythmias	On Ventilator		Off Ventilator		p value
	<40 yrs	>40 yrs	<40 yrs	>40 yrs	
Ventricular ectopic	11	10	02	05	P <0.01
Ventricular Bigeminy	01	04	01	01	
Ventricular run	02	05	00	00	
Ventricular tachycardia	00	03	01	01	
Ventricular fibrillation	00	02	00	00	

Patients more than 40 years on artificial ventilation were at increased risk of developing hemodynamically significant arrhythmia and silent ischemia as compared to patient less than 40 years. There was association between age more than 40 years and development of arrhythmias (p<0.01). Ventricular fibrillation was seen exclusively in two patients on ventilator.

**Table no. 5 : period of hospitalizations and arrhythmias**

Arrhythmias	Patient <= 8 days	Patient > 8days	p value
Ventricular ectopic	12	16	p >0.05
Ventricular Bigeminy	05	02	
Ventricular run	04	03	
Ventricular tachycardia	03	02	
Ventricular fibrillation	01	01	

There was no association between duration of hospital stay and development of arrhythmia in this study ( $p > 0.05$ ). However statistical comparison was not possible because of small sample size.

**Table no. 6 : ventilators and arrhythmias**

Arrhythmias	On Ventilator		Off Ventilator		P value
	<8 Days	>8 Days	<8 Days	>8 Days	
Ventricular Ectopic	11	10	02	05	p >0.05
Ventricular Bigeminy	04	01	01	01	
Ventricular run	04	03	00	00	
Ventricular tachycardia	02	01	01	01	
Ventricular fibrillation	01	01	00	00	

There was no association between duration of hospital stay and development of arrhythmias whether patients were on ventilator or not ( $p > 0.05$ ). However statistical comparison was not possible because of small sample size.

**Table No.7: Association Of Arrhythmias And Heart Rate Variability**

Arrhythmias	No. of patients	SDNN <=100MS	%	P value
Ventricular ectopic	28	23	82.14	p <0.05
Ventricular Bigeminy	07	04	57.14	
Ventricular run	07	04	57.14	
Ventricular tachycardia	05	02	40.00	
Ventricular fibrillation	02	02	100	

The occurrence of arrhythmias in critically ill non-cardiac patients with SDNN value less than 100ms were higher than with SDNN more than 100ms. There was strong

association between development of ventricular arrhythmia and depressed HRV ( $p < 0.05$ ).

**Table No.8: Association Of Arrhythmias, Heart Rate Variability And Ventilator**

Arrhythmias	On Ventilator		Off Ventilator		P Value
	SDNN < 100ms	SDNN > 100ms	SDNN < 100ms	SDNN > 100ms	
Ventricular ectopic	14	07	03	04	P <0.05
Ventricular Bigeminy	04	01	01	01	
Ventricular run	04	03	00	00	
Ventricular tachycardia	02	01	01	01	
Ventricular fibrillation	02	00	00	00	

Patients with ventricular arrhythmias and on ventilator had depressed HRV. There was association between patients on ventilator, depressed HRV and occurrence of significant cardiac arrhythmia ( $p < 0.05$ ). Patients on ventilator had depressed HRV hence more likely hood of occurrence of hemodynamically significant arrhythmias.

**Table No.9: Association Of Silent Ischemia, Age And Ventilator**

Age		ST Displacement
<40 Years	On Ventilator	04
	Without Ventilator	00
>40 Years	On Ventilator	05
	Without Ventilator	02

Silent ischemia seen in patients on ventilator (32%) was more as compared to patient with out ventilator (15%). However statistical comparison was not possible because of small sample size.

Patients more than or equal to 40 years of age had higher rate of developing silent ischemia 36.84%. However statistical comparison was not possible because of small sample size.

Silent ischemia was seen more frequently in patients with age more than 40 years on ventilator. However statistical comparison was not possible because of small sample size.

## Discussion:

In present study, we studied

1. Arrhythmias &
2. Silent Ischemia (ST Depression)
3. Heart Rate Variability in critically ill non cardiac patients by 24 hours Holter monitoring (on mechanical ventilation and without it).

## 1. Arrhythmias

In present study Holter Monitoring was done in critically-ill non-cardiac patients for 12 to 14 hours. In present study ventricular premature complexes (VPC's) were found in 80%, ventricular runs (VR) in 15.55%, ventricular bigeminy 15.55%, ventricular tachycardia 11.11% and ventricular fibrillation in 4.40% patients respectively. More than 10 VPC's/hr were present in 38.88%, 1-10VPC's/hr in 50%, (SVT) in 15.55% and supra ventricular ectopics (SVE) 62.22% respectively

Development of hemodynamically significant cardiac arrhythmias in critically ill non cardiac patients leads to increase mortality, prolongation of hospital stay and difficulty in weaning from ventilator. However in present study, patients were not treated with any anti-arrhythmic (drugs or DC shock) per se, because it not diagnosed on routine bedside monitor.

Our study is slightly comparable to study conducted by AD Costa, MM Rieder et al<sup>13</sup> as it showed development of significant arrhythmias in critically ill patients admitted in ICU both with heart disease and without heart disease. While our study showed development of cardiac arrhythmia in only patients without heart disease.

Arrhythmias that were commonly found in critically ill non-cardiac patients, on ventilator were ventricular ectopic 88.85%, followed by SVE 52.00% least commonly seen was ventricular fibrillation 8%. Ventricular fibrillation had occurred in two patients on artificial ventilation.

In present study we found that significant cardiac arrhythmias i.e. ventricular fibrillation and ventricular tachycardia was more frequently occurred in patients on ventilator. There was association between development of significant ventricular arrhythmia and ventilator ( $p<0.05$ )

Study conducted by Koh Y, Kim TH, Lim CM et al<sup>13</sup>

observed that during the early stages of mechanical ventilation with acute respiratory failure, hemodynamically significant cardiac arrhythmias are directly associated with tachycardia ( $\geq 120$ /min), initial MAP ( $<70$ mm Hg), and, inversely with the initial use of pressure-controlled ventilation.

Study conducted by by AD Costa, MM Rieder et al<sup>14</sup>, on mechanically ventilated patients observed development of significant arrhythmias in 27% of the patients with heart disease and in 11% of the patients those without heart disease, also ST segment changes were observed more often in those with heart disease than in patients without heart disease. ( $p<0.05$ )

Our study is lightly comparable to study conducted by AD Costa, MM Rieder et al<sup>14</sup> study, as in our study significant arrhythmias had occurred in critically ill non cardiac patients, on ventilator.

In present study we found that patients with age more than 40 years were at increase risk of developing significant cardiac arrhythmias and ST segment changes.

## 2. Heart Rate Variability (RRV or HRV)

The index studied for HRV in present in study was SDNN. It was found to be depressed i.e. SDNN less than 100 ms in 71.11% of patients. SDNN less than 100ms was frequently associated with development of significant cardiac arrhythmias ( $p<0.05$ ).

The value of SDNN obtained in the present study was  $73.93\pm 37.49$ ms, which is in accordance with that suggest by The Task Force.<sup>15</sup>

### Association of Arrhythmias and Abnormal HRV:

In present study, patients with depressed HRV i.e.  $SDNN<100$ ms (table no.7), VPC's were found in 67.77%, Ventricular run in 11.76%, Ventricular Bigeminy in 11.67%, Ventricular tachycardia in 5.88%, Ventricular fibrillation in 4.04%, Supraventricular tachycardia in 9.3%,

Kennedy, Harold et al<sup>16</sup> observed that heart rate variability is a potential, non invasive prognostic index in the critically ill patient for development of significant arrhythmia.

There was association between depressed HRV and the development of significant cardiac arrhythmias ( $p < 0.05$ ).

### Influence of Ventilator on HRV:

In our study out of 45 patients, 25 were on ventilator, in them ventricular ectopic and supraventricular ectopics and ventricular tachycardia (table no.2) was found to be common as compared to patients without ventilator. Patients on ventilator had depressed HRV and higher rate of arrhythmias as compared to patients without ventilator; hence chances of significant arrhythmias were more in critically ill non cardiac patients on artificial ventilation.

### 3) Silent Ischemia

In our study we found myocardial ischemia in 24.24% (11/45) patients during Holter monitoring and all of the episodes were silent. It had been observed that silent ischemia is more commonly seen in patients more than equal to 40 years of age i.e. 34% However statistical comparison was not possible because of small sample size.

In our study, patients on artificial ventilation were at increase risk of developing silent ischemia 32.00% than patients not on ventilator 15.0%. Silent ischemia in patients on ventilator was more as compared to patients without ventilator.

Landesberg et al<sup>17</sup> observed a 21% rate of myocardial ischemia using continuous 12-lead electrocardiographic monitoring in ICU patients at high risk for coronary artery disease; 66% of the patients in this study were mechanically ventilated.

Our detection of ischemia in 32% of patients is similar to the rates of ischemia reported by Landesberg et al<sup>17</sup> and various other studies.

### Summary And Conclusion

- A total of 45 patients were monitored by 24 hours Holter monitoring for arrhythmias, silent ischemia and heart rate variability (HRV) in critically ill non-cardiac patients.

- Out of 45 patients, 25 were on ventilator.
- Age more than or equal to 40 years was important risk factor for the development of arrhythmia and ST-T changes.
- Silent ischemia was present, as documented by Holter monitor in 11 patients, of them, majority were on ventilator.
- Some form of arrhythmias were presents in majority of patients.
- Those on ventilator had higher incidence of arrhythmia like ventricular ectopic, supraventricular tachycardia. Ventricular fibrillation was exclusively seen in patient on ventilator.
- Majority of patients on ventilator had depressed HRV.
- Depressed heart rate variability ( $SDNN < 100ms$ ) was associated with development of arrhythmias.
- During Holter monitoring 4 patients died, all of them died because of cardiac arrhythmia followed by cardiac arrest. One of them was on ventilator and developed silent ischemia followed by Ventricular fibrillation and cardiac arrest.

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