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Arrhythmia Burden in COVID-19 Patients from Industrial Workforce Evaluated by Remote Patient Monitoring Technology

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Abstract

Introduction: Reports from China showed that overall cardiac arrhythmia prevalence in patients hospitalized for COVID-19 was about 17%. Furthermore, in patients admitted to intensive care unit, a higher arrhythmic incidence (44%) was observed. Considering that workforce from industabnormalitiesd was affected by COVID-19 to a great extent accompanied by cardiac abnormalities, our study targeted this group. Remote patient monitoring was used to enhance the clinician's ability to monitor and manage patients in tertiary healthcare settings. The prevalence of clinically significant, clinically non-significant and normal heart rhythm is described here.

Methods: This was a retrospective, observational, descriptive study from Telangana State, India. Approval of the institutional ethics committee was obtained, and informed consent was waived. Patients of both genders aged more than 18 years with confirmed COVID-19 positive determined by RTPCR method were eligible. The 5 days recording of Lead 2 ECG that were obtained utilizing Vigo Heart Monitoring Solution (Vigocare Pvt. Ltd) was collected and analysed irrespective of patient's clinical status. Brady-arrhythmia (Heart rate <40 for >30 seconds) during daytime, second degree AV block Type-2 (Mobitz II) during the daytime, complete heart block, wide QRST (heart rate >100 for 30 seconds), non-sustained ventricular tachycardia (>3 seconds) and sinus pause (>3 seconds) were considered clinically significant. The other sub-types were defined as clinically non-significant. The ECG with regular sinus rhythm was interpreted as normal.

Results: Out of 240 COVID-19 patients who were onboarded for remote monitoring, 216 (148 male and 68 female, mean age 51±15 years) met the eligibility criteria and only their ECGs were analysed. Among them, 18 were known diabetic, 40 were hypertensive and 31 had both comorbidities. Asymptomatic were 112 and

symptomatic 104 respectively. The burden of arrhythmia was found clinically significant in 12 (5.6%) patients, clinically non-significant in 87 (40.4%) and normal among 117 (54%) respectively out of 216 patients.

Conclusion: The remote patient monitoring may be utilized as a tool for early screening of significant arrhythmia which can be addressed immediately for better clinical outcomes. These devices on being integrated into COVID-19 management strategies may contribute to patient satisfaction, emergency alerts, timely management, reducing mortality rate while enhancing the safety of healthcare providers.

Keywords: COVID-19, Arrhythmia, Remote Patient Monitoring, Artificial intelligence, Industrial workforce

Introduction

For the most part, hospitalized Covid-19 patients and their respiratory abnormalities were targeted but the impact from cardiac issues seemed overlooked. The early reports from China estimated that an overall cardiac arrhythmia prevalence in patients hospitalized for COVID-19 was 17% (1). Furthermore, in patients admitted to the intensive care unit, a higher arrhythmia incidence (44%) was observed (2). Arrhythmias are not an uncommon manifestation of viral infections, and it appears that it is typically initiated by viral myocarditis affecting the cardiac conduction system (3). The myocardial inflammation leading to electrophysiological and structural remodelling could be the mechanism through which SARS-CoV-2 leads to different arrhythmias (4). The arrhythmias could also be secondary to the side effects related to medication (unknown status of drugs under emergency use authorization or in a compassionate use program), hypoxia, activated protein kinase C or direct oxidized Ca2+/ calmodulin-dependent protein kinase II activity and myocarditis (5). In COVID-19 the cardiac arrhythmias are significantly associated with poor outcomes (6).

Remote patient monitoring (RPM) has been proven to be enhanced clinicians' ability to monitor and manage patients in non-traditional healthcare settings (7). RPM uses digital technologies to collect health data from individuals in one location, such as a patient's home, and electronically transmitting the information to healthcare providers in a different location for assessment and recommendations (8). Wherein the 24/7 vitals data (ECG, HR, RR, Temp, SPo2) is continuously recorded using wireless biosensors and transferred to the cloud based IoT platform using the mobile app. Vigo Multivital monitoring is such a technology where it acts as a remote monitoring platform to capture, record and analyse the physiological data of the patient in real time or offline. The ECG Analysis powered by Artificial Intelligence can help a clinician detect arrhythmias and QT prolongations at the earliest . The powerful artificial intelligence ECG Analysis system (Cardiology-USFDA Approved) has been used for arrhythmia detection. RPM devices integrated into COVID-19 management strategies, could contribute to patient satisfaction, emergency alerts, timely management, and safety of healthcare providers. RPM may be used as a tool for the early screening of arrhythmia and help clinicians differentiate against the arrhythmia's prognostic importance, facilitating more effective risk stratification pertaining to COVID-19 patients (9).

The integration of patch biosensor (VV330) Vigo Heart with IoT based Vigo software platform and AI-DNN model for ECG-interpretation serves as an ideal technology to enable remote patient monitoring to identify cardiac rhythm abnormalities (10).

The present retrospective study has been planned to evaluate the arrhythmia burden in Covid-19 patients.

The study was conducted with the objective to determine the prevalence of arrhythmia in COVID 19 infected patients. Also, to ascertain the burden of clinically significant, clinically non-significant and normal heart rhythm abnormalities or arrhythmia.

Materials and Methods

The study was a descriptive, retrospective study and the data collected was from the patients records of hospitalised industrial workforce admitted to ESIC hospital during June 2019 to July 2019. The Vigo multivital monitoring technology was employed on the patients admitted to ESIC as a part of remote patient monitoring (RPM). The Vigo multivital monitoring solution has the below devices integrated to the software platform to monitor the patients' parameters as shown in the Table1. The ECG reports of the COVID-19 patients were retrospectively reviewed and analysed for arrhythmia to understand its prevalence in Covid-19 infected patients. The presence of covid-19 was confirmed with RT-PCR positive test report.

Table1: Vigo Multivital Monitoring -Remote Patient Monitoring (RPM) Technology

Sn.	Device	Parameter/Vital Sign
1	Vigo Heart (VV330)	Heart rate, Respiratory rate, ECG
2	Armfit BP cuff (BP2A)	Non-Invasive Blood pressure (NIBP)
3	Axillary Temperature (VV200)	Axillary Temperature
4	Pulse Oximeter (O2 Max)	Spo_2 and Pulse Rate

Technology and Patients Monitoring

Vigo Multivital monitoring (see Figure 1) is an ambulatory patient monitoring solution kit comprising of VV330 wearable biosensor patch, BP Cuff, Axillary Temperature and Pulse Oximeter. All these devices are integrated to the Vigo platform with an inbuilt Artificial Intelligence engine for ECG Analysis.

The devices are connected to the mobile application (Vigo Life) for the data capture after placing them on the patient in their respective positions to capture different physiological vital signs such as HR, RR, A. Temp, ECG, NIBP, SPO_2 and PR respectively. The captured data is transmitted to the Vigo platform which is an ISO 13485: 2016 and MDSAP approved platform which is categorized to be software as a medical device (SaMD).

Pertaining to arrhythmia detection, the data is analyzed by FDA approved AI engine with 21 CFR 870.1425 to detect any abnormalities in the ECG. The reports are further verified by the certified ECG technicians before publishing.

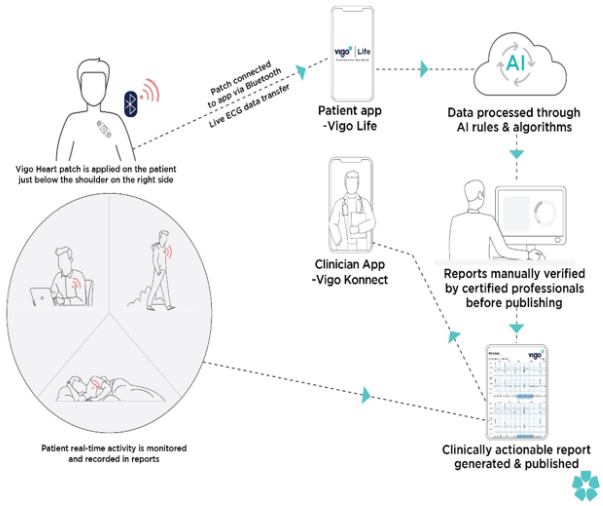

Figure 1: Onboarding and Monitoring the Patient.

Research Settings

Institutional ethics committee approval was obtained with the number ESICMC/SNR/IEC-F288/05-2021 and informed consent was waived since we received anonymous data. The 5 days recording of Lead-2 ECG that were obtained utilizing Vigo Multivital Monitoring Solution (Vigocare Pvt Ltd) wascollected and analysed retrospectively irrespective of patient's COVID-19

clinical status and severity. Data of the patients of both genders, age more than 18 years with confirmed COVID-19 positive by RT-PCR method was considered for analysis. Data belonging to pregnant and lactating women were excluded for analysis.

Intervention

After confirming the COVID-19 positive status, the patients were triaged as asymptomatic, mild, moderate, severe, or critical based on the criteria established by the ministry of health and family welfare (MOHFW). Irrespective of severity, all the patients were on-boarded to Vigo Vitals monitoring solution. Based on preliminary assessment and inclusion criterion, the patients were onboarded as a part of remote patient monitoring.

Outcome Assessment

Brady-arrhythmia (heart rate <40 for >30 seconds) during daytime, second degree AV block Type-2 (Mobitz II) during the daytime, complete heart block, wide QRST (heart rate >100 for 30 seconds), non-sustained ventricular tachycardia (>3 seconds) and sinus pause (>3 seconds) were considered clinically significant. The others sub-types were defined as clinically non-significant. The ECG with regular sinus rhythm were interpreted as normal.

Statistical Methods

The descriptive statistics performed for mean and standard deviation was measured. The study was conducted with 95% of confidence interval with a P value 0.01which is statistically significant. All the statistical analysis was performed using the IBM SPSS version 20 software developed by Norman H. Me in 2011 at Chicago.'

Results

Out of 240 COVID-19 patients who were on-boarded (November 2020 to August 2021) for remote monitoring, 216 (148 male and 68 females, mean age 51±15 years) 90 % of the patients met the eligibility criteria with minimum age 18 and maximum being 85 years. The eligible patient's ECGs were analysed using Artificial Intelligence (AI) technology and the report was manually verified by the expert ECG tram before being published. Among them 18 (8.3%) were known diabetics, 40 were hypertensive (18.5%) and 31 had both the comorbidities (14%). Asymptomatic were 112 (52%) and symptomatic 104 (48%) respectively.

The burden of arrhythmia was estimated as clinically significant in 12 (5.6%) patients, clinically non-significant in 87 (40.4%) and normal among 117 (54%) out of 216 patients respectively. The total arrythmias identified during the retrospective analysis was mentioned in Table3. The mean age of all significant arrhythmia patients was calculated as 54.73 with a standard deviation of 19.528 and the demographic details were mentioned in Table 2. The different types of arrhythmias detected through remote patient monitoring are presented in Table 3.

Table 2: Patient's Demographic Details

Gender (N=216)	
Male (n=148)	68.52%
Female (n=68)	31.48%
Mean age (51±15 years)	
Males	50± 14 years
Females	53± 16 years
Comorbidity	
Diabetics (n=18)	8.34%
Hypertensive (n=40)	18.51%
Diabetic and Hypertensive (n=31)	14.35%
Covid-19 Status	
Symptomatic (n=104)	48.14%
Asymptomatic (n=112)	51.85%

Table 3: Types of Arrhythmias Detected Through RPM in COVID-19 Patients.

Type of Arrhythmias	No. of Patients
Accelerate Junctional Rhythm	2
Accelerated Idioventricular Rhythm	1
Atrial Fibrillation	10
Biphasic P-waves	4
Brugada Syndrome	1
Complete AV block	1
First Degree AV Block	10
Intermittent T-wave inversions	1
Intermittent Junctional Rhythm	1
Intraventricular conduction delay	2
Non-sustained ventricular tachycardia	4
Pauses	7
Premature supraventricular contractions run	1
Paroxysmal supraventricular tachycardia	32
Short PR interval	1
Sinus Arrhythmia	117
Sinus Atrial Exit Block	2
Sinus Bradycardia	1
Sinus Rhythm	6
Sinus Tachycardia	3
S-T depressions	1
Supraventricular tachycardia	2
T-wave inversions	5
Wandering Atrial Pacemaker	1
Grand Total	216

Complete heart block was detected in one patient in the forenoon hours of day one of monitoring. During the course, maximum heart rate was found to be 78 beats per minute and minimum heart rate was 26 beats per minute receptively and AV block burden was less than 1%.

Sinus pause more than 3 seconds was found in seven patients, among them the covid-19 status was symptomatic in 2 patients and asymptomatic in other 5 patients. In asymptomatic patients one patient had a history of hypertension and the other was a diabetic and the significant arrhythmia classification was mentioned as below in Table 4.

Table 4: Classification of Significant Arrhythmia

Significant Arrythmias (n=12)	
Type of Arrhythmias	No. of Patients
Bradycardia <40 during daytime for >30 secs	n=0
Type II Mobitz	n=0
Type II second degree	n=0
Complete heart block	n=1
Wide QRS complex >100 for 30 secs	n=0
NSVT >3 secs	n=4
Sinus pause >3 secs	n=7

Discussion

Cardiac involvement in COVID-19, whether caused primarily by the virus, secondary to its clinical sequelae, or even due to its treatment cannot be ignored. Thorough cardiac exams with electrocardiographic correlation should be performed on all patients with COVID-19 (10). Cardiovascular complications in coronavirus disease 2019 (COVID-19) patients have been associated with poor prognosis (11). Hospitalized COVID-19 patients should be monitored closely on telemetry to promptly recognize any arrhythmia; hence preventing an unexplained rapid decline in cardiopulmonary status by

intensifying care and managing the arrhythmia in a timely manner (12) (13).

As per the results obtained in the study, many of the arrythmias are asymptomatic and non-lethal to the patients which are non-significant and normal as per the report classification by Ministry of Health Govt of India classification. However the precipitation of significant arrythmia during the covid patients are higher than the arrhythmia prevalence in normal population which is < 2 %(14). The arrhythmia untreated or unnoticed may leads to udden cardiac death which significantly contributes to the mortality in Covid 19 infected patients (15,16).

The study revealed that the highest number of patients 55 (25.46%) out of 216 were between the age group of 48-57 which is the most active working group in the Indian setting. The same age group has been suffering from most of the comorbid conditions such as HTN (40) and DM (18) or both (31). With respect to Covid symptoms, out of 55 patients, there were 21 asymptomatic and 34 symptomatic patients. However, significant arrhythmias were reported in only 3 patients in the age group of 48-57 whereas 10 significant arrythmias were identified in 68-77 years patients age group. This reveals that age is one of the important factors for developing arrhythmia.

Remote Patient Monitoring with wearable and point of care cardiac monitoring solutions facilitate effective and preventive screenings without disturbing the daily routine of the patient. Arrhythmias detected during exercise, and especially at recovery can be lethal. The NSVT's indicates increased cardiovascular mortality in the next decades (17,18).

Conclusion

The remote patient monitoring may be utilized as a tool for early screening of significant arrhythmia which can be addressed immediately for better clinical outcomes These devices on being integrated into COVID-19 management strategies have contributed to proactive cardiac rhythm abnormalities detection. The Remote patient monitoring with an IoT platform such as Vigo software Platform ensures the safety of medical personnel, and timely management of the patient with the help of digital data availability. The patient data availability at different software interfaces for a doctor facilitates the doctor to take quick decisions on the treatment plan which will contribute to the reduced mortality and increase patient satisfaction levels.

Limitations and Strengths: Retrospective study

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