

IDENTIFICATION OF THE ARRHYTHMIAS AND MYOCARDIAL INFRACTION IN PILGRIMS VISITING KEDARNATH TEMPLE IN UTTARAKHAND USING A SMARTPHONE 12-LEAD ECG DEVICE

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Abstract: Every year, about 1.5 million pilgrims visit the 14 km long Kedarnath temple trek on foot at the height of 3584 meters above sea level. In 2022, the months of May and June reported a drastic increase in mortality due to Myocardial infarction in the pilgrims. Hence, a health camp was organized for heart health checkups in the symptomatic pilgrims. In the heart checkup camp, screening of symptomatic pilgrims was done using the smartphone-based Spandan 12 lead ECG device developed by Sunfox Technologies Private Limited, India. A Standard operating procedure was followed for monitoring and follow-up of the pilgrims with ongoing arrhythmias or Myocardial Infarction. The ECGs of the pilgrims with persistent symptoms like palpitations, chest pain, shortness of breath, dizziness, and past medical history of hypertension, coronary interventions, smoking behavior, and diabetes were collected at the health camp. The reports with abnormal ECG were provided with immediate referral to the health care center. Whereas a tablet of 150 mg anti-platelet drug was given to pilgrims having critical and abnormal ECG. These pilgrims were immediately referred to the nearby district hospital. A total of 2343 pilgrims visited the Health camp for the screening, out of which 583 cases were pre-screened to be prone to cardiac abnormalities. The 12 lead ECGs collected from heart abnormalities prone patients were shared with a cardiologist at the Nodal center in Dehradun, Uttarakhand. 423 ECGs were interpreted as normal, 62 were abnormal, and 90 pilgrims were critical. Follow-ups taken after two days for pilgrims detected early for the abnormal and critical ECGs reported no casualties. Smartphone-based ECG device presents an impact in saving the lives of the people in Kedarnath by accessing the status of their cardiac health before trekking to the Kedarnath temple.

Keywords: cardiac arrhythmia, smartphone ECG, validation, myocardial infarction

Introduction

The Electrocardiogram is the primary tool to diagnose cardiac abnormalities in medicine. In the past few years, there has been a sudden rise in heart attacks in India leading to sudden death due to lack of its detection. The ECG can be used in case of detection of Arrhythmia and ST Elevated Myocardial Infarction (STEMI) and Non-ST- Elevated Myocardial Infarction (NSTEMI). When experiencing these symptoms that might be brought on by cardiac arrhythmias, people frequently visit their primary care physician for treatment.[1] The symptoms that prompt individuals to consult their primary care physician include palpitations, lightheadedness, and (near) fainting.[2] Cardiac rhythm abnormalities,

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such as ectopic beats, are frequent ECG findings that normally don't require therapy.[3] The abnormalities like atrial fibrillation (AF) or atrial flutter (AFL) that affect 2% to 3% of total population need specialized assessment and timely treatment that can lower the risk of stroke and heart failure when remain undiagnosed.[4] Recent development of the smartphone based ECG devices have induced the revolution the digital public health by improving the rate of timely diagnosis and treatment of these widespread medical issues, many of the wearable technologies are associated with arrhythmia detection capabilities like Ventricular Premature Complexes and Premature Atrial Complexes, this can effectively provide a control over arrhythmia monitoring to the patients .[5]

Smartphone Based ECG devices have not been proven to have high sensitivity but also clinically accepted specificity in detect of the Arrhythmia, STEMI and NSTEMIs. Many such smartphone-based ECG devices have shown that the user experience is not the issue for a non-trained person. The clinicians and healthcare professionals have improved their practice by providing correct diagnosis on time. In case of screening of the cardiac abnormalities in the masses, the sensitivity of the traces and specificity of the abnormality detection should be high, which can ensure low fallacy in the interpretation provided by these smartphone-based ECG devices. In 2022, Kedarnath temple trek in Rudraprayag District of Uttarakhand India recorded the highest deaths due to cardiac problems in three years. Hence, in this study the cardiac screening camp was organized for the longitudinal period to manage the heart attack risk in the region. Along with the standard operating procedure of loading people with cardiac abnormalities, the health camp was also equipped with the smartphone-based ECG machine.

The Spandan is a 12 lead Smartphone based ECG developed by Sunfox Technologies Private Limited, Uttarakhand, India was chosen as the reference smartphone based ECG device for the health camp as it was able to detect both STEMI, NSTEMIS and Arrhythmias .[6] Prior studies on this device shows that this technology has been clinically reliable and accurate for the diagnoses and a non-medical persons may be able to utilize it anywhere in the globe.[7] Even highly skilled medical professionals may be able to employ this technique in resource-constrained nations like India where conventional ECG equipment is not frequently accessible to obtain a trustworthy 12-lead ECG trace at a reasonable expense.[8-10]

Given the study's objectives were to identify arrhythmias, ST-elevated myocardial infarction, and non-ST elevated myocardial infarction among pilgrims visiting the health camp prior to the Kedarnath temple trip. The study consisted of pilgrims visiting the shrine on foot for the distance of 24 kilometers (about 14.91 mi) at a altitude of 3583 meters (about 2.23 mi) above sea level. Hence, at such an altitude, shortness of breath and palpitations are a common issue for the aged people. This study not only screened the people with such symptoms but also included a standard operating

procedure of prescribing a loading medicine if the condition of the patient was found critical like VT, SVT, AF and acute MI. This study was found to be unique because it was the first time such kind of smartphone ECG machine were used in the altitude of Himalayan terrain and no relative literature were available in the domain for the same.

Materials and Methods

2343 pilgrims visited the cardiac screening camp. After getting their signed informed permission, researchers enrolled trekking pilgrims in this study in the months of May 2022 to October 2022. After Screening the enrolled participants for the symptoms of cardiac abnormalities a total of 583 participants were found to be prone of the cardiac illness. Upon advancing the screening by execution of their 12 lead ECG, it was found that a total of 152 individuals who were having abnormality related to the cardiac illness and can be classified into 62 as abnormal and 90 as critical irrespective of their genders.

Analysis of Arrhythmias: Tachyarrhythmias and bradyarrhythmia's like the sinus tachycardia, sinus bradycardia, atrial tachycardia, atrial flutter, atrial fibrillation, junctional rhythm, ventricular tachycardia, AV-block, high degree AV-block, supraventricular ectopic, ventricular ectopic, WPW syndrome, and supraventricular tachycardia were considered in the SOP for classification Abnormal and critical reports. ECGs were produced and evaluated in accordance with guidelines given by a team of cardiologists in Sir Ganga Ram Hospital, Delhi and Max Super Specialty Hospital, Dehradun. These SOPs were executed by the research team which included the loading of the pilgrim in the ambulance if ECG is found critical and correlating a chest pain, shortness of Breath. The SOP also included providing 150mg of antiplatelet to patients showing Acute MI correlating with chest pain. In case of Arrhythmias, the pilgrims were suggested to not to continue the trek as it can lead to fatalities. The 12 lead ECGs were recorded while the patients were lying down and resting as shown in figure 1. After being granted permission to lie down, the screening was conducted as per the SOPs.



Figure 1: Real-time ECG recording through Spandan smartphone 12-Lead ECG device.

12-lead ECG recordings: With a sample frequency of 500Hz, the 12-lead ECGs were captured using the Spandan 12L ECG equipment. While the individuals were in resting positions, the nurse recorded their ECGs using a 12-lead Spandan ECG for intervals of 10 seconds. One of the applications of the Smartphone ECG allows the patient to submit the ECG recordings to Google cloud-based servers. A team of cardiologists working blindly assessed 12-lead ECG on a smartphone and the normal ECG machine for interpretation of the cardiac abnormalities. ECGs were categorized as normal, abnormal and critical based on the certain systematic operation procedure which included the correlation of symptoms like shortness of breath, palpitation, chest pain followed by parameters like Blood Pressure and blood oxygen concentration.

Analysis of STEMIs: STEMIs that were taken into account for this investigation included anterior wall, anterior septal, anterior lateral, lateral, inferior wall, inferior lateral, inferior septal, right branch bundle block, and left branch bundle block. ECGs were produced and evaluated in accordance to the systematic operating procedure which were used to categorized the reports as normal, abnormal and critical. The ECGs were recorded while the patients were in supine position or resting.

Statistical methods

Analyses of descriptive statistics were carried out after the data were gathered on an MS- excel sheet. The screening camps outcomes were directly correlated to the decrease in the deaths in the Kedarnath region due to cardiac problems. The data was accessed from the Chief Medical Officer of Rudraprayag District of Uttarakhand for the region's casualties and checked for the cardiac screening camp's effectiveness.

Results and Discussion

Out of the total of 583 abnormal pilgrims found to be prone of the cardiac illness, 82.9% were males and rest were females. The research population's baseline characteristics are detailed in Table 1 below. The average pilgrim visiting the screening camp was found to be 43.59 years.

4.6% of the pilgrims visiting the health camp had a prior history of cardiac disease as they went through some Primary Cardiac Intervention (PCI). Whereas 53.2% were found to be hypertensive along with this, 36.18% of people had a smoking history of more than 5 years. There was total 90 cases found critical with either MI or with Arrhythmias, among which 25 Cases were of STEMI, 23 cases were of myocardial Ischemia and 10 cases were of Arrhythmias. Additionally, it has been noted among workers who are tasked with serving customers that the rate of health problems is 62.5% (with confidence intervals between 50.6% to 73.4%). However, for workers that do not interact with

customers are found to have a prevalence rate of 49.7% (with the confidence interval spanning from 38.0%, to 61.5%).

Table 1: Baseline characteristics of pilgrims with abnormal and critical ECG (n=152)

Variable	Subcategory	Mean \pm SD	Number	Percentage (%)
Average (Years)	Age NA	43.5 \pm 14.1	NA	
Male		126		82.9
Female		26		17.1
Obesity		25		16.4
Smoking		55		36.18
Hypertension		81		53.2
PCI		7		4.6
Diabetes		18		11.8
STEMI		25		16.44
Ischemia		23		15.13
LBBB		9		5.9
RBBB		23		15.1
Arrhythmia		10		6.5
Medication	Antiplatelets	90		59.2
Follow-up	Healthy	152		100
	Death	0		0

This study made a significant contribution by showing that the smartphone ECG can recognize an ST-segment myocardial infarction, non-ST elevated myocardial infarctions, and arrhythmias utilizing a technological platform that is already accessible. This is crucial because it allows electrocardiographic assessment to be applied in novel use case situations, such as personalized use by the owner or point-of-care, out-of-hospital initial medical contact. One of the most important ones is when a standard 12-lead ECG is not readily available. Out of 152 cases, 90 critical cases related to STEMI, NSTEMI and Arrhythmias were loaded to the ambulance by providing a 150 mg tablet of Anti-platelet drug. These patients were sent to the nearest medical facilities with Cath lab. After the Follow up with these patients, it was found that all the critical patients detected for cardiac abnormalities were safe and sound after the timely intervention at the Cath lab.

A conventional Standard 12-lead ECG equipment could not be made available in circumstances such as a pilgrimage trek due to its heavy weight, requirement of the continuous power supply, but the readily availability of the smartphones might provide the groundwork for a wider use of

electrocardiography. Our research revealed a high degree of STEMI accuracy across smartphone ECG records and traditional ECG readings. [11-13] The remarkable innovation in mHealth based on smart device technology, including their portability, straightforward connectivity, and ubiquitous nature—have made it possible to provide clinical decision-makers and patient-facing therapeutic assistance with extended care and diagnostic capabilities. access to the point of care.[14] With the usage of 12-lead ECGs captured on publicly accessible smart devices and uploaded very fast to a shared cloud-based server, healthcare delivery and provision may alter. To improve accessibility and timeliness of care, local hospitals or healthcare systems, EMS companies, and community organizations may decide to design and sign up for services that incorporate monitoring, alarms, and two-way contact.[15]

Technology is advancing faster than our present healthcare system; hence the goal of this study is to find out whether a 12-Lead ECG acquired with a smartphone can accurately diagnose STEMI. If this is the case, further research needs to assess the "sharing capabilities" of the smartphone ECG and establish whether non-clinicians may utilize it outside of a hospital context. It has been seen in the studies that the nurses were far better at ease making single lead recordings than receptionists using these smartphone ECG devices.[16] There were several advantages to our investigation. By including consecutive individuals who obtained a 12L ECG as part of routine medical care, we first developed a cohort that could be used to general practices.[17]

The Spandan's modest weight and tiny dimensions are also expected to promote patient compliance with using the device. The commonly known way to record an ECG among the smartphone ECG based device is Acquisition of Lead II position, which is ideal for the detection of the arrhythmias but have a high chance of missing MIs and Arrhythmias sensitive to ECG electrode positions. Many studies have shown that it is possible to detect AF with a commercially available smartphone-based ECG device, with diagnostic accuracy, and good sensitivity and specificity. According to this, smart devices having lead II ECG recording capacities generally have the capacity to screen for and monitor AF. Whereas a 12 lead Based Smartphone ECG can mobilize the detection and treatment of the MIs and Arrhythmias. Hence, in the selection of the device for the screening camps are ideal as the general population of India have prevalence of MI more than Arrhythmias like AF.

The ideal approach to identify atrial fibrillation were 12-lead ECGs and blood pressure monitors.[18] Moreover, the accuracy values for new smartphone applications are inconsistent in recent studies. Haberman et al. discovered that in patients in cardiology clinics, the handheld ECG with single lead data acquisition had a sensitivity of 94% and a specificity of 99%.[19] Hospitalized patients had lower readings with a sensitivity range of 55-79% and a specificity range of 97.5-97.9%, according to Spandan smartphone ECG showed that it has specificity and Sensitivity to record the 12 lead ECG for rhythms abnormalities, STEMI, NSTEMIS and Arrhythmias like AF. [20-22]

Limitations:

A potential flaw in the study was that the average population age was 43 years old, which was older than the 43-year average for the Indian population. Apart from the screening, the interventions provided to critical patients should have been considered.

Conclusion

The STEMI reaction is a time-sensitive activity requiring quick and decisive action. Making the diagnosis faster can possibly save lives. The diagnostic and treatment procedure can be accelerated with the help of a mobile application. An easy-to-use, independent smartphone software called Spandan has produced positive results in identifying rhythm anomalies. It is important to co-relate the ECG findings with the cardiac symptoms. Hence, for practicing the best of the techniques in public health care to cope up with the Epidemic of cardiovascular disease, it is important to use these smartphone devices with the SOPs as its independent use can cause increase in false positives. Ultimately leading to panic among the population.

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Declaration of Interest Statement

The authors declare that they have no conflict of interests.

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