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Prevalence and Severity of ECG Anomalies in a Rural Australian Population

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Authors' contribution

This work was carried out in collaboration between all authors. Author HFJ designed the study, performed the analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors LW and PW managed the analyses of the study. Author HAA managed the literature searches and. draft the final version of the manuscript. All authors read and approved the final manuscript.

Original Research Article

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ABSTRACT

Aims: To determine the prevalence and severity of cardiac arrhythmias in a rural Australian population using ECG assessment.
Study Design: This is a University-based research project. Comparative design with random samples used.
Place and Duration of Study: School of Community Health, Charles Sturt University, Albury, NSW, Australia.
Methodology: Five hundred and eight participants with or without a known history of cardiovascular disease were recruited via public media announcements indicating a health screening opportunity carried out at the local university. Their medical history was obtained and a 12-lead electrocardiography (ECG) was recorded. ECG recordings were classified into severity and prevalence determined in each category. The number of participants that had to be referred and had follow-up by the general practitioner was

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determined.
Results: Moderate to severe ECG anomalies, which included atrial fibrillation or left bundle branch block were identified in 58 (11.4%) of the participants. Forty (7.9%) individuals with ECG anomalies were referred to the general practitioner for further evaluation. Eight participants did not seek further advice. Twenty-two (68.8%) participants that made an appointment to see their general practitioner were either commenced on treatment, had their treatment changed or received surgery. A further 85 (16.7%) of individuals required regular follow-up in line with their ECG characteristics and other health information, presenting with non-clinical ECG changes that had the potential for adverse health outcomes in the future including long QT interval, right bundle branch block or left ventricular hypertrophy for instance.
Conclusion: Our study has demonstrated that a substantial number of patients in this rural community have both ECG abnormalities and or cardiac arrhythmias that required regular review or commencement of treatment by their doctor.

Keywords: Cardiac arrhythmias; electrocardiography; type 2 diabetes mellitus; cardiovascular disease.

1. INTRODUCTION

Cardiovascular disease (CVD) represents a significant burden on health care systems around the world. In the United States and Australia, chronic heart disease is the leading cause of death [1-3]. In addition, the EUROASPIRE I and II studies in 1995 and 2000 respectively indicated that the prevalence of cardiovascular risk factors such as hypertension, lipid disorders and obesity have increased substantially. Cardiac arrhythmias are common causes of cardiac morbidity and mortality [4]. Identification of individuals with clinical relevant cardiac arrhythmias and sub-acute ECG changes enables timely implementation of effective therapeutic regiments that may significantly reduce this burden [5-10].

Routine screening for ECG anomalies and cardiac arrhythmias is not generally implemented in primary health care settings, although many people with cardiac arrhythmias may remain asymptomatic and undiagnosed before an ECG examination [11] and present for the first time due to angina or severe cardiac pathology requiring hospitalization. Reasons against routine ECG screening include the value of ECG in identifying non-arrhythmic CVD disease and the costs involved in large screening programs[12]. However ECG screening in a targeted community can be cost-effective [13-18].

The primary purpose of this study was to investigate the prevalence and severity of cardiac anomalies and arrhythmias as identified by a 12 lead ECG in a rural Australian population attending a health review clinic, advertised in the local media.

1.1 What This Paper Adds:

a. What is already known on this subject?

- 12 lead ECGs form an important part of clinical diagnosis

- Cardiovascular disease, and its causes including hypertension, hypercholesterolemia, smoking, obesity and diabetes are more prevalent in the rural community.
- Community screening for cardiovascular disease is however controversial due to the low prevalence of clinical significant findings and the cost in population screening.

b. What does this study add?

- This study shows that a substantial portion of the population can be identified as 'at risk' and appropriately referred to general practice for follow-up based on the ECG results.
- Those at possible risk are identified and can be followed up by the university-based screening clinic.
- University-based rural screening projects can have a positive contribution to rural health when combined with existing primary health services.
- University based screening programs may also be more cost effective as well as improve the clinical assessment skills of undergraduate students in both nursing and medicine.

2. MATERIALS AND METHODS

The project was approved by the Charles Sturt University Human Ethics Committee. Participants were recruited through the public media in Albury-Wodonga, a city of approximately 100,000 inhabitants situated on the New South Wales-Victorian border of eastern Australia. The only restriction for attendance at the CVD screening program was that participants needed to be over 45 years of age. It is recognised that adults under 45 years of age with no underlying pathology have a low risk of developing CVD. A standard medical history was obtained and a 12-lead ECG (Welsh-Allyn) was recorded. ECG traces were assessed at the clinic and results provided to participants. The Welsh-Allyn software provides automated classification of the ECG traces using the Minnesota protocol, which were checked by the attending cardiac nurse and a cardiologist. All ECG results were divided into five categories ranging from normal to severe (Table 1). Cases were primarily referred on the basis of ECG abnormalities and or arrhythmias with some referrals due hypertension and other health factors including, an elevated blood sugar, cholesterol or a significantly elevated body mass index.

Table 1. Showing severity of ECG anomalies and common underlying findings for each type

ECG Category	Common Underlying Findings
Normal	- Sinus rhythm - Sinus arrhythmia
Normal variant	- Slow rhythm (HR < 60) - Conduction delay of atrial or ventricular origin - LAD - RAD - LVH

Table 1 continued.....

Mild	- 1° heart bock - Notched or peaked P waves (atrial enlargement) - Peaked T waves (hyperkalaemia) - PVC - PAC - LAFB - RAFB (left anterior or left posterior hemiblock)
Moderate	Inverted T waves without symptoms Prolonged Q-T interval Bigeminy or trigeminy (ventricular) Bradycardia (HR <50) 2° heart block, Mobitz type 1 or 2 Pathological Q-waves in 2 or more leads (old infarct) - Atrial Fibrillation
Severe	- Ventricular tachycardia (conscious) - LBBB - RBBB - Multifocal PVC/ PAC - ST segment depression/elevation in more than 1 lead

**LVH = Left ventricular hypertrophy; PVC = premature ventricular contraction, PAC = premature ventricular contraction; LAFB = Left anterior fascicular block; RAFB = Right anterior fascicular block; LBBB = left bundle branch block; RBBB = right bundle branch block; LAD = left axis deviation; RAD = right axis deviation*

3. RESULTS AND DISCUSSION

A total of 508 people were recruited to the study and completed a 12-lead ECG assessment. General data of the participants are shown in Table 2.

Table 2. Demographics of non-diabetes and diabetes group

Parameter	Participants (N = 508)
Females/males	301/207
Age	60 ± 13 (range)
CVD*	71
Hypertension	102
Body Mass Index	28 ± 6 (range)

**known cardiovascular disease excluding hypertension*

3.1 Participants with no History Cardiovascular Disease

In the group with no reported CVD, moderate or severe ECG anomalies were found in 33 (6.5%) of the 437 subjects with no recorded history of cardiovascular disease, (Table 3).

Table 3. ECG anomalies in 437 participants with no reported cardiovascular disease (CVD)

ECG Category	Participants (N= 437) N (%)
Normal and normal variant	264 (60)
Mild	140 (32)
Moderate	23 (5)
Severe	10 (3)

Ten participants with severe ECGs were immediately referred to their general practitioners. The most common finding for referral for further investigation was left bundle branch block (LBBB) and atrial fibrillation (AF). However the majority of participants presented with more than one ECG anomaly including normal variants and mild-moderate anomalies in the ECG including left axis deviation (LAD), left ventricular hypertrophy (LVH), inverted T waves, ST-elevation in more than one lead, first degree (1°) heart block and significant q-waves in more than one lead. Although these abnormalities for the main part are sub-clinical and confer little if any symptoms they may indicate underlying disease, especially LAD, LVH and segment changes.

New treatment was commenced by the general practitioners in two of these patients. Four individuals had RBBB, which did not require further management whilst the remaining four received treatment (2 by-pass surgeries, 1 pacemaker, and one commenced medication). Following analyses and feedback with specialists, RBBB was recommended to be reclassified by the specialists reviewing the cases into the mild category and LVH was placed in the moderate from mild.

Twenty-three patients with moderate ECG anomalies were recommended to discuss their findings with their general practitioners. Five of the thirteen patients who sought advice had antihypertensive and antiarrhythmic medication commenced. One with hypertension also showed left ventricular hypertrophy (LVH), inverted T waves and multifocal premature ventricular contractions (PVCs), whereas the other two with hypertension showed intraventricular conduction delay as seen by a widened QRS interval. The fourth patient received lipid-lowering medication and the fifth patient, a pacemaker.

Eight individuals received no treatment but presented with an ECG anomaly that should be reviewed by a specialist and belongs to the moderate ECG anomaly group. Of these one had ventricular trigeminy, whilst another had drug-induced long QT interval, a potentially fatal finding frequently requiring a modification of medication by their doctor. A third was identified with a minor heart valve problem by the general practitioner following referral for inverted T waves, left axis deviation and PVCs. In addition five individuals presented with either: LVH, long QT, inverted T waves, bradycardia, intra-atrial conduction delay and pathological q-waves or a combination of these.

ECG anomalies cannot be or should not be used in isolation for referral from a screening program, they do however often suggest underlying non-specific pathologies as can be seen by the following results. In the mild ECG anomaly group, one individual presented with 1° heart block and inferior T wave inversion and had a pacemaker inserted after the ECG abnormality was identified at the screening and following further clinical investigation by the specialist. Two individuals with normal variants of the ECG had a more complex aetiology in addition to their ECG findings and received surgical intervention. One with pronounced LVH

and intra-atrial conduction delay received a pacemaker. The other presented with premature atrial contractions (PAC) and Grade 3 hypertension and received coronary by-pass surgery. To summarise these results, two individuals with a normal variant, one with mild, five with moderate and six with severe ECG anomalies received treatment as a consequence of the screening outcome. Ten individuals in the moderate group elected not to follow up with an appointment with the GP or specialist despite our recommendation. Fourteen 14 (87.5%) participants received treatment following referral, which constitutes 3.2% of those that reported no CVD and were assessed at the clinic. Six individuals (1.4%) did not require referral. Two were already on treatment and four presented with RBBB.

3.2 Participants with Known History Cardiovascular Disease

In the 71 patients with CVD, four of the twelve identified with serious ECG anomalies had their medication changed by their general practitioner following referral. Also in this group of patients, four with moderate ECG findings as outlined in Table 1 were referred to their general practitioner for further assessment. The ECG findings in 3 of the 4 patients were deemed to be due to antihypertensive therapy. In all cases, the general practitioner indicated that referral was appropriate and considered change in treatment. Eight of 25 patients or (32%) received follow-up by their general practitioner. This equates to 11.2% of the total in the known CVD group (Table 4).

Table 4. ECG anomalies in participants with known history of cardiovascular disease (CVD)

ECG Category	Patients (N= 71) N (%)
Normal and normal variant	26 (37)
Mild	20 (28)
Moderate	13 (18)
Severe *	12 (17)

** These were under current treatment by the general practitioner or cardiologist for known CVD*

Opportunistic ECG screening of asymptomatic individuals is not recommended by the majority of government agencies including the American Heart Foundation (AHA). However, with a targeted population, such as those with family history, age over 55 years and those with type 2 diabetes, ECG recording is recommended as part of physical examination [19-21].

Our research has shown that the proposed ECG severity scale used as a basis for appropriate referral to a physician is accurate and has possibly saved lives by referring patients with or without known CVD for review, resulting in pharmacological or surgical intervention. Evidence that ECG abnormalities are independent predictors of morbidity and mortality in people without definitive heart disease was reported by the Framingham study using a 2-minute rhythm strip [22]. A Netherlands study of arrhythmia detection in general practice reported a clinically relevant ECG in 36% of patients with symptoms and 19% in asymptomatic patients [23]. In our study clinically relevant ECG anomalies were identified in 25 of 71 (35%) participants with known CVD and 33 of 437 (8%) with no known CVD. It is thus important to include both individuals with and without known CVD. This is evident from the finding that three of four individuals in the moderate group with CVD had ECG findings associated with antihypertensive therapy and required a change in medication despite regular reviews by the consulting physician. This may be due to patients sometimes

receiving a continuation on their script for antihypertensive medication without attending a consultation or a change in medication may have an effect that is asymptomatic and therefore not seen unless routine ECGs are taken. The identified patients were referred correctly to their primary health care physicians and received further treatment or review. Only a small proportion (4.7%) of referrals did not lead to further medical intervention, which included the RBBB referrals. Therefore in a future update to Table 1 RBBB should be moved to the mild category.

In our study participants were referred for follow-up if their ECG showed moderate to severe anomalies. However, several with normal to mild anomalies were also referred to the general practitioner primarily due to elevated blood pressure being also present. Further investigations by their doctor and cardiologist led to hospitalisation and or surgery. Although reliance on ECGs to detect cardiovascular disease in screening programs is not generally accepted as having a high enough sensitivity and specificity, our screening program detected 8% of ECG anomalies in asymptomatic individuals, leading to referral directly to the general practitioner or to hospital. These results indicate that ECG screening in a targeted rural population would help identify sub-clinical conditions that in many instances are undetected leading to potentially serious outcomes for the patient. Similarly targeted screening as in our research project that includes a higher proportion of the elderly with increased prevalence of ECG anomalies and CVD has shown an increased likelihood of identifying cardiovascular disease in the undiagnosed participants [13,24].

4. CONCLUSION

The aim of the study was to show that ECG classification using the included Minnesota code is a strong and effective tool for identifying ECG anomalies and rhythm disturbances in a primary health care setting. The information collected and compared to our severity table provides an effective tool in identifying individuals that should be referred to their doctor for further review and also provides a picture of common ECG anomalies in this rural population. The is of particular significance as it highlights the degree to which a 12 lead ECG used and interpreted appropriately has the potential to significantly reduce morbidity and mortality of members of the community, both with and without diagnosed CVD. Our study has demonstrated that a substantial number of patients in this rural community have cardiac arrhythmias that required review or commencement of treatment. ECG screening in a targeted rural population helps to identify potentially serious cardiac arrhythmias that require treatment.

CONSENT

All authors declare that written informed consent was obtained from all participants of this present study.

ETHICAL APPROVAL

All authors hereby declare that all experiments have been examined and approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

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COMPETING INTERESTS

We state that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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