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Diabetes and poor glycaemic control in rural patients with coronary artery disease☆

Catherine Ngan [a,*,1], Ya-Chu May Tsai [a,1], Dharshan Palasubramaniam [a,1], Amy Wilson-O'Brien [a,1], Jamie Layland [a,1], Robert Whitbourn [b,1], Andrew Wilson [a,1]

[a] The University of Melbourne, Department of Medicine, St Vincent's Hospital, Melbourne, Australia
[b] St Vincent's Hospital, Melbourne, Australia

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ABSTRACT

Background: The burden of cardiovascular disease is higher in rural populations. Existing data on rural cardiovascular health is mainly based on community surveys. Regional differences are not well addressed. This study aims to identify regional inequalities in cardiovascular risk factors (CVRFs) in Australian patients with suspected coronary artery disease.

Methods and results: 538 subjects (72% male; mean age 63 years) were recruited from a single cardiac catheter laboratory over a 24-month period. Subjects were stratified into Remoteness Areas (RAs) according to the Australian Standard Geographical Classification (RA1 corresponds to Major Cities, RA2 to Inner Regional Areas, RA3 to Outer Regional Areas). Body-mass index, blood pressure, hypertension, dyslipidaemia, diabetes and smoking history were recorded. A blood sample taken before the angiogram was analysed for lipids and fasting blood glucose (FBG). Distribution of the study population across RA1, RA2 and RA3 was 34.8%, 46.1% and 19.1%. Only FBG ($p = 0.019$) and diagnosed diabetes ($p = 0.009$) were significantly different i.e. higher in RA1. Of those without known diabetes, RA3 had the highest prevalence of dysglycaemia ($p = 0.023$) with two-thirds having either pre-diabetes or undiagnosed diabetes. Logistic regression showed that age and RA3 were the only statistically significant predictors of elevated FBG.

Conclusion: CAD patients from remote Australia had higher rates of pre-diabetes, undiagnosed diabetes and poorer glycaemic control. Analysis of the main CVRFs revealed a regional inequality in the recognition and management of diabetes alone. Attention to this gap in rural and urban healthcare is crucial to future cardiovascular health outcomes in Australia.

1. Introduction

Cardiovascular disease (CVD) is the leading cause of non-communicable deaths in the world, accounting for almost 40% of deaths under 70 [1]. With population ageing being a significant global trend, particularly in developed countries, CVD mortality and morbidity are projected to rise substantially. In developed countries such as the United States, Canada, UK and Australia, CVD is the first or second leading cause of mortality, with coronary artery disease being the chief specific cause of death in these countries [2–5]. In addition to its impact on national mortality and morbidity, CVD also imposes significant financial and societal cost from the magnitude of healthcare expenditure, loss of productivity due to work absenteeism, early retirement and premature mortality [6]. It follows that managing the burden of CVD is a health priority in the modern society.

It is well accepted that the progression of ischemic heart disease is linked to a history of modifiable and inherited characteristics, and thus addressing modifiable cardiovascular risk factors (CVRFs) are mainstays for management of general cardiovascular health [7,8]. Knowledge of the geographic prevalence of these risk factors is essential to the formation of population specific health policies and targeted delivery of health services. In particular, the countries mentioned above face the challenge of addressing the health concerns of rural and urban communities; 20–30% of US, Canadian and Australian populations live outside of Major Cities, where there are unique geographical, lifestyle and health characteristics.

The impact of CVD is particularly high in these rural populations, where in Australia the disease burden can be up to 15% greater [9]. Rates of cardiovascular hospitalisations and deaths increase with remoteness, significantly contributing to the overall poorer health outcomes in regional and remote communities [10–13]. There is also a

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* Corresponding author at: The University of Melbourne, Department of Medicine, St Vincent's Hospital, Melbourne, Australia.
E-mail address: c.nganie@gmail.com (C. Ngan).

[1] This author takes responsibility for all aspects of the reliability and freedom from bias of the data presented and their discussed interpretation.

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greater prevalence of modifiable CVRFs in populations outside of the Major Cities, with higher rates of hypertension, obesity, smoking and risky alcohol consumption [11,13].

Since much of the burden of CVD can be decreased by managing CVRFs, greater knowledge of the specific differences in risk factor awareness and management across rural populations is vital to improving health outcomes. Awareness of regional health has been a focus of Australian health policy for many years, and the existing literature on this topic is based on comprehensive risk factor surveys of regional and national health [11,14,15]. Local studies on CVRFs have recruited from electoral rolls or used Census data, where rurality has not necessarily correlated with cardiovascular mortality or morbidity [16,17], or the findings have been gender specific [18]. However, the usefulness of this data is limited by the lack of blood tests in determining the presence of a risk factor, relying instead on patient recall and potentially reflecting patient awareness rather than true prevalence. Conditions that rely on diagnostic blood tests, such as diabetes, are thus likely under-reported. Another feature of these population surveys is that there is little focus on groups most at risk.

In contrast, this study examines the regional prevalence and management of CVRFs in patients with suspected coronary artery disease, in a well-characterised Australian population. The investigation of reported and biochemical risk factors along with angiographic evidence offers a fresh insight into cardiovascular healthcare in a group of patients for whom risk factor management is a priority.

2. Methods

2.1. Ethics approval

This study was approved by the St Vincent's Hospital Research Governance Unit, in accordance with National Health and Medical Research Council guidelines. All patients were invited to participate before their procedure and written consent was obtained.

2.2. Study population

Study subjects were recruited from St Vincent's Hospital Melbourne, which is a major tertiary public teaching hospital. Patients presenting to the St Vincent's Cardiac Catheterisation Laboratory between May 2009 and May 2011 for coronary angiography and/or percutaneous coronary intervention (PCI) were eligible for this study. Subjects were recruited as part of the **B**iomarke**r**s of **A**therosclerosis, **V**ascular and **E**ndothelial Dysfunction in **Heart** Disease Study (BRAVEHEART), and thus the following exclusion criteria were applied: patients with chronic or acute infections, systemic inflammatory conditions, recent or untreated malignancies and serum creatinine levels greater than 160 μmol/l.

2.3. Patient data

Cardiovascular histories were obtained through interview and review of medical records. The use of hypoglycaemic, lipid lowering and antihypertensive medication was recorded. Blood pressure (BP) on admission and body-mass index (BMI) were recorded. BMI was calculated as body weight in kilograms divided by the square of the height in metres. Hypertension was defined according to the 2007 Cardiac Society of Australia and New Zealand (CSANZ) Guidelines as BP >140/90 mm Hg [19]. Obesity was defined according to the World Health Organisation (WHO) Guidelines as BMI ≥ 30 kg/m^2 [20]. Severity of CAD was angiographically assessed by a cardiologist. Vessel disease was defined as a greater than 50% stenosis of a major coronary artery or history of stenting of that artery. The location of disease and the number of diseased vessels were recorded.

2.4. The ASGC-RA classification

This study uses the Australian Standard Geographical Classification-Remoteness Areas (ASGC-RA) system, which was devised by the Australian Bureau of Statistics to organise data into broad geographical categories based on population size and distance from an urban centre [21]. The Remoteness Area (RA) boundaries are updated after each Census, and this report is based on the 2006 Census, which at the time was the most recent. To classify the study population, the postcode of the subject's current address was obtained from the hospital registry. All subjects were classified into three RAs: Major Cities, Inner Regional Areas and Outer Regional Areas.

2.5. Biochemical blood analysis

Arterial blood samples were collected via femoral or radial arterial access at the beginning of angiography before the use of iodinated contrast agent. Samples were analysed through St Vincent's Pathology for lipid profile, fasting blood glucose (FBG) and glycated haemoglobin (HbA1c). Normal FBG and HbA1c levels were defined according to the 2004 American Diabetes Association (ADA) Guidelines [22]: normal FBG <5.6 mmol/l, impaired FBG 5.6 to 6.9 mmol/l, diabetic FBG ≥7 mmol/l and normal HbA1c <6.5%. Normal lipid levels were defined according to the 2007 CSANZ Guidelines [19]: total cholesterol (TC) <4 mmol/l, low-density lipoprotein cholesterol (LDL-C) <2.0 mmol/l, high-density lipoprotein cholesterol (HDL-C) >1.0 mmol/l and triglycerides (TG) <1.5 mmol/l.

2.6. Statistical analysis

Statistical analyses were undertaken using SPSS 17 statistical software. Continuous variables were examined for normality of distribution with the Kolmogorov–Smirnov test. Variables not normally distributed were appropriately log-transformed for parametric analyses. Differences in physical measurements, reported risk factors, biochemical risk factors and severity of CAD across the RA groups were determined by one-way analysis of variance (ANOVA) with post-hoc Tukey analysis for continuous variables, and chi-square analysis for discrete variables. Logistic regression analysis was used to assess independence of correlations, and to identify the variables most significantly associated with elevated FBG. The variables included in the model were age, gender, hypertension, dyslipidaemia, smoking history, BMI, use of hypoglycaemic medication, the presence of CAD and RA. Significant values were defined as $p < 0.05$.

3. Results

3.1. Characteristics at baseline

538 subjects (72% male; mean age 63 years) were included in the analyses. All subjects were Victorian residents and were classified by their postcode into Major Cities, Inner Regional Areas and Outer Regional Areas as defined by the ASGC-RA system [21]. There were 187 subjects from Major Cities (75% male, mean age 61 years), 248 from Inner Regional Areas (70% male, mean age 63 years) and 103 from Outer Regional Areas (72% male, mean age 64 years) (Table 1, Fig. 2).

Table 1
Baseline characteristics.

Total number in population	538
Average age (years)	63 (0.5)
Gender	72% male
Remoteness Area (number of patients)	
Major Cities	187
Inner Regional	248
Outer Regional	103
Reported CVRF (%)	
Hypertension	81%
Dyslipidaemia	87%
History of smoking	71%
Diabetes mellitus	27%
Anthropometric measurements	
BMI (kg/m^2)	29.6 (0.2)
Systolic BP (mm Hg)	135 (1)
Diastolic BP (mm Hg)	82 (1)
Biochemical risk factors	
FBG (mmol/l)	6.4 (0.1)
HbA1c (%)	6.1 (0.1)
TC (mmol/l)	4.3 (0.0)
TG (mmol/l)	1.6 (0.0)
HDL-C (mmol/l)	1.1 (0.0)
LDL-C (mmol/l)	2.5 (0.0)
Medication	
Reported diabetes (n = 146)	
Hypoglycaemic medication	67%
Reported hypertension (n = 434)	
Antihypertensives	81%
Reported dyslipidaemia (n = 465)	
Lipid lowering medication	81%
Angiography	
Coronary artery disease	70%
1 vessel disease	27%
2 vessel disease	23%
3 vessel disease	21%

Data expressed as mean (standard error of mean) where appropriate. CVRF represents cardiovascular risk factor; BP, blood pressure; BMI, body-mass index; FBG, fasting blood glucose; HbA1c, glycated haemoglobin; TC, total cholesterol; TG, triglycerides; HDL-C, high-density lipoprotein cholesterol; and LDL-C, low-density lipoprotein cholesterol.