Q waves and ventricular extrasystoles in resting electrocardiograms
A 16 year follow up in Busselton study

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SUMMARY Isolated abnormalitites in the resting electrocardiograms of 1546 Busselton people with no history of angina or past myocardial infarction were examined in relation to 16 year mortality. Multivariate discriminate analysis in men showed significant independent relationship for Q waves with coronary heart disease and for ventricular extrasystoles with cardiovascular disease. In women multivariate analysis showed significant relations for ventricular extrasystoles with total mortality and coronary heart disease. There were higher trends in mortality for both men and women with frequent ventricular extrasystoles compared with those with infrequent ventricular extrasystoles.

In a recent paper on the problems of estimating prognosis Crow *et al*.[1] have pointed out that it is important to determine whether or not a mortality finding is by chance or due to other factors. The authors believe that the risks for an electrocardiographic abnormality could be more accurately estimated by a multivariate analysis, including other electrocardiographic findings, blood pressure, blood lipids, smoking habits or activity, and behaviour type. Of the relatively few such analyses that have been published multivariate analysis of the Framingham data showed no significant increases in mortality for ventricular extrasystoles,[2] nor for right bundle branch block.[3] Left bundle branch block in Framingham men,[4] however, contributed independently of age, blood pressure, diabetes, coronary heart disease, and congestive heart failure, to an increased risk of death from cardiovascular disease.

In a previous report on Busselton electrocardiograms,[5] the 13 year mortality relating to abnormalities in resting electrocardiograms was analysed in two groups of people. Firstly, a univariate analysis in unselected subjects showed significantly higher coefficients and mortality ratios for cardiovascular disease in those whose initial electrocardiogram showed Q and QS patterns, left axis deviation, ST depression, T wave depression, flat or biphasic T

waves, atrial fibrillation or flutter, or ventricular extrasystoles. A further analysis concerned angina free subjects without a history of myocardial infarction whose electrocardiographic codes occurred in isolation of any other electrocardiographic abnormality. The univariate analysis showed that ventricular extrasystoles were the only electrocardiographic code to be associated with significantly higher mortality from cardiovascular disease compared with controls.

In view of the few publications on the multivariate analysis of electrocardiograms, we report the significant coefficients for the 16 year mortality shown by multivariate discriminant analysis of isolated electrocardiographic abnormalities and other risk factors for cardiovascular disease in Busselton subjects.

Subjects and methods

In November 1966 mass health examinations were undertaken on unselected volunteers in the coastal town of Busselton in rural Western Australia.[6] Of the total available population defined by the compulsory electoral roll, 91% attended for this examination. Each subject was given the questionnaire for chest pain of Rose,[7] venepuncture one hour after 50 g of glucose, and their heights, weights, and ratios of forced expiratory volume in one second to forced vital capacity were measured. Resting electrocardiograms were recorded and classified according to the Minnesota code.[8] The subjects chosen for the study had

Table 1 *Standardised regression coefficients for Busselton 16 year mortality in symptom free subjects aged 40–74 at entry including electrocardiographic abnormalities found in isolation of other electrocardiographic codes*

Cause of death	Men (n = 828)		Women (n = 717)	
All causes	(No. of deaths 218)		(No. of deaths 97)	
	Age	0·3401***	Age	0·2824***
	%FEV	−0·1607***	Age^2	0·1804***
	SBP	0·1141***	%FEV	−0·0852*
	Age^2	0·1469***	Ventricular	
	Smoker	0·0887**	extrasystoles	0·0933**
	Calcium	0·0619*	Uric acid	0·0909**
			Calcium	−0·0796*
Cardiovascular	(No. of deaths 114)		(No. of deaths 51)	
disease	Age^3	0·3096***	Age	0·2479***
	SBP	0·1443***	Age^2	0·2121***
	Ventricular		Sugar	0·0828*
	extrasystoles	0·0741*	Uric acid	0·0792*
	Smoker	0·0753*		
	Cholesterol	0·0692*		
Coronary heart	(No. of deaths 61)		(No. of deaths 21)	
disease	Age	0·1654***	Age^3	0·2514***
	SBP	0·1134**	Ventricular	
	Q waves	0·1067**	extrasystoles	0·0978**
	Cholesterol	0·0923**		

*p<0·05; **p<0·01; ***p<0·001.
FEV, forced expiratory volume in one second; SBP, systolic blood pressure.

no previous history of angina or myocardial infarction, and all subjects who showed more than one electrocardiographic code were excluded from the analysis.

Risk factors relating to the 16 year mortality were examined in the 828 men and 718 women aged 40–74 years at entry to the study. Mortality for the group was confirmed by the registrar of deaths in Perth, Western Australia, all missing subjects being checked against the registrar's files for possible deaths. Multiple regression analysis of risk factors with mortality was undertaken in relation to all first causes of death occurring between January 1967 and December 1982. The ICD 8th revision (1968) codes used to determine mortality resulting from cardiovascular diseases were ICD codes 390–458 and 746–747; for coronary heart

disease codes 410–414 were used. For the regressions on mortality, since the determining variables are correlated multivariate discriminant analysis was used to ensure that claimed risk factors in fact exerted independent effects. The sequential regression procedure included stepwise inclusion of important variables. This continued until the final equation was obtained with all variables having a significant contribution (p<0·05). The multiple regression discriminant analysis of the statistical package of the social sciences was used on the Busselton data.

Results

Table 1 outlines the significant multiple regression coefficients for 16 year mortality in Busselton subjects

Table 2 *Sixteen year mortality and mortality ratios for 1545 Busselton subjects aged 40–74 years with isolated Q waves or ventricular extrasystoles in those free of angina and myocardial infarction*

	Men							Women	
	No	Died		Died		All causes	MR	No	Died
Electrocardiographic abnormality		CHD	MR	CVD	MR				CHD
Q waves	11	4	5·2**	4	2·7**	5	1·7	8	0
Ventricular ectopics (10% or more of total no of beats)	9	2	3·0	4	3·3*	4	1·7	2	0
Ventricular ectopics (less than 10% of total no of beats)	23	3	1·8	6	1·9*	8	1·3	20	3
Total ventricular ectopics	32	5	2·2	10	2·4**	12	1·5	22	3

*p<0·05; **p<0·01.

Age specific mortality rates have not been tabulated in view of the small number of deaths in the individual categories. Mortality ratios were similar, however, in the age groups 40–59 years v 60–74 years.
CHD, coronary heart disease; CVD, cardiovascular disease; MR, mortality ratio.

aged 40–74 years at entry. The following electrocardiographic abnormalities could not be part of the analysis as they were found only in conjunction with other electrocardiographic abnormalities: ST segment depression, T wave inversion, and complete left bundle branch block. The following isolated electrocardiographic abnormalitites had significant relations with mortality: (*a*) ventricular extrasystoles with total mortality in women (p<0·01); (*b*) ventricular extrasystoles with cardiovascular mortality in men (p<0·05); (*c*) Q waves in men (p<0·01) and ventricular extrasystoles in women (p<0·01) with coronary heart disease.

Table 2 outlines the 16 year mortality in 54 subjects with isolated ventricular extrasystoles. Mortality for those with frequent ventricular extrasystoles was more than twice those with infrequent ventricular extrasystoles.

Discussion

The use of the resting electrocardiogram for routine screening has long been common practice in hospitals and private consulting rooms. Many abnormalities occur in conjunction with other clinical evidence of heart disease. In this event the prognosis of the electrocardiographic findings cannot be separated readily from that of the underlying pathology. In general terms, prognosis is dominated by other evidence of heart disease, although in many cases the coexisting electrocardiographic changes increase the risk of death. These cases present fewer problems to the physician than those concerning isolated electrocardiographic abnormalities in apparently otherwise normal subjects. In this report we have shown that Q waves and ventricular extrasystoles have an independent effect on mortality.

Q WAVES
Large abnormal Q waves occurring as an isolated finding in symptom free men have been reported. In 18 403 British male civil servants aged 40·64 years Rose *et al.*[9] reported a five year age adjusted mortality ratio of 27·9:1 and risk ratios of 4·1:1 for medium sized Q waves and 2·1:1 for small Q waves. By comparison, 2254 people aged 65 studied during a three year period by Caird *et al.*[10] had a mortality risk ratio of 1·8:1 for all types of Q waves. Blackburn *et al.*[11] reported a slight (but not significant) increase in coronary heart disease in those with minor Q waves among 12 770 men aged 40–59 years over a five year period. Isolated Q waves in the Busselton 16 year data were shown on multivariate analysis to be an independent risk for coronary heart disease in men. The combined evidence suggests that isolated Q waves represent a risk of death that is independent of other vascular factors.

VENTRICULAR EXTRASYSTOLES
A number of reports including those from various population studies have found no significant relation between ventricular extrasystoles and mortality.[12–17] Multivariate analysis in the Framingham[3] and seven countries[17] studies found no significant independent risk for ventricular extrasystoles in relation to deaths due to coronary heart disease, cardiovascular disease, or total mortality.

A recent report from the Manitoba study[18] concerned the 10·8 year prognosis of 401 people with ventricular extrasystoles in clinically normal hearts. The relative risk of sudden death was 1·05 for those aged 40–49, 4·20 for those 50–59 years, 3·28 for those aged 60–69 years, and an age adjusted total of 4·18. The age specific incidence of total ischaemic heart disease was significantly (p<0·05) greater in men aged 40–59 years compared with controls without ventricular extrasystoles. Faster basic ventricular rates were correlated with a greater probability of ischaemic heart disease. Crow *et al.*[1] have praised this work for its excellent follow up, size of sample, and

| | Died | | All causes | MR | All subjects | | | | | | |
| | | | | | No | Died | | Died | | Died all causes | MR |
IR	CVD	MR				CHD	MR	CVD	MR		
–	2	3·6	2	1·9	19	4	4·1*	6	3·0**	7	1·8
–	1	7·2	2	7·5**	11	2	3·5	5	4·4**	6	2·7*
·8**	3	2·2	6	2·3*	43	6	2·8*	9	2·0*	14	1·6*
·3*	4	2·7	8	2·8**	54	8	3·0**	14	2·6*	20	1·9*

approach to analysis, but they did not consider that the Manitoba findings could be accepted at face value in view of the lack of comment about other electrocardiogaphic findings, blood pressure, blood lipids, activity, smoking habits, or behaviour types.

The Busselton study seems to be the first in which a multivariate analysis has shown an independent effect on mortality for isolated ventricular extrasystoles. The regressions on mortality for ventricular extrasystoles reached significant levels in men for cardiovascular disease and in women for coronary heart disease and for total mortality (Table 1). For the remaining two categories for ventricular extrasystoles that did not reach significance (Table 2), the mortality ratio for ventricular extrasystoles with coronary heart disease in men was 2·2 and for cardiovascular disease in women was 2·7. Kennedy and Underhill[14] carried out coronary angiography on 25 people with complex ventricular extrasystoles and found appreciable coronary obstruction in six. The conclusions of Kennedy et al.[18] were somewhat different concerning ventricular extrasystoles discovered on 24 hour ambulatory electrocardiogaphic monitoring in a further 18 patients with no apparent cardiac disease. Although all subjects had normal coronary arteriograms, 72% had multiform or repetitive patterns with more than half having increased left ventricular and systolic volume (56%), 67% having increased left ventricular end diastolic volume, and 56% having increased left ventricular end diastolic pressure. They concluded that most people with ambulatory ventricular extrasystoles in apparently normal hearts showed myocardial dysfunction.

In conclusion, the Busselton report reiterates the importance of carrying out multivariate as well as univariate analysis on electrocardiographic abnormalities. Despite the negative multivariate findings concerning ventricular extrasystoles in the Tecumseh,[12] Framingham,[3] and seven countries[17] studies, the findings of significant risks for ventricular extrasystoles and the higher trends in mortality for frequent ventricular extrasystoles compared with infrequent ventricular extrasystoles in Busselton men and women suggest the need for caution in assessing the prognosis of isolated ventricular extrasystoles. We hope that results of multivariate analysis from other prospective studies will clarify further the risks of ventricular extrasystoles in symptomless people with no other evidence of heart disease.

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