Prevalence of abnormalities of electrocardiogram in old people

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The electrocardiograms of 2254 people aged 65 or over and living at home have been classified according to the Minnesota code.

62 per cent of records showed no significant abnormality. The proportion was slightly less in men than in women, and fell sharply with age.

Q/QS patterns were seen in 6 per cent, twice as commonly in men as in women. ST-T abnormalities (8%) were commoner in women, as were left ventricular hypertrophy patterns (9%).

The most frequent conduction defects were left bundle-branch block, right bundle-branch block, left anterior hemiblock, and incomplete right bundle-branch block, each of which was present in 1.4-2.0 per cent.

Atrial fibrillation was present in 2 per cent under the age of 75, and 5 per cent over that age.

The findings are discussed in the light of other studies of random samples of old people.

A Community Health Service for the Elderly was set up in October 1970 in Scotland's first new town, East Kilbride, which has a total population of 67,000. Health visitors and home nurses attached to the Burgh Health Department visit people aged 65 and over on the lists of each general practitioner, and complete a simple structured questionnaire, which incorporates questions on physical symptoms and environmental factors. Each person who agrees to participate is invited to attend a clinic where a physical examination is carried out by his own general practitioner or by a Local Authority Medical Officer, a standard 12-lead electrocardiogram is recorded, and the peak expiratory flow rate measured (Wright and McKerrow, 1959).

Most investigations of the frequency of abnormalities of the electrocardiogram in old age have been based on groups of elderly hospital patients or residents in institutions (Wosika *et al.*, 1950; Fisch *et al.*, 1957; Taran and Szilagyi, 1958; Mihalick and Fisch, 1974), and there have been relatively few studies of fit old people living at home (Ostrander *et al.*, 1965; Kennedy and Caird, 1972; Kitchin, Lowther, and Milne, 1973; Martin and Millard, 1973). The present paper describes the electrocardiographic findings in over 2000 old people who attended clinics in the first three years

of operation of the East Kilbride Community Health Service for the Elderly, and takes advantage of the standardization of electrocardiographic reporting provided by the Minnesota Code (Blackburn *et al.*, 1960; Rose and Blackburn, 1968).

Methods

Between October 1970 and October 1973 technically adequate electrocardiograms have been recorded on 2254 participants, whose age and sex are shown in Table 1. Two observers with experience of electrocardiography independently classified each electrocardiogram according to the Minnesota Code (Blackburn *et al.*, 1960), as modified by Rose and Blackburn (1968). Disagreements occurred in about 15 per cent of cases, and were resolved by joint re-examination of the record.

The following modifications of the code were employed:

- 1) Records showing left axis deviation (Code II.1) were divided into those which did and did not fulfil the criteria of Rosenbaum, Elizari, and Lazzari (1970) for left anterior hemiblock. To allow for the identification of the combination of right bundle-branch block and left anterior hemiblock Code II.1 was recorded in the presence of right bundle-branch block (Code VII.2).
- 2) The following codes were not employed: III.2 (high amplitude R waves in right praecordial leads), V.4 (optional code for low amplitude T waves), VIII.0 (combinations of arrhythmias), and IX.0 (combination of miscellaneous items).

Received 1 May 1974.

TABLE 1 Age and sex of subjects

Age group		65-69	70-74	75-79	80-84	85+	65-74	75+	Total
Men:	No.	507	225	93	38	9	732	140	872
	Population*	605	390	215	105	30	995	350	1345
	Per cent of population	84	58	43	36	30	73	40	65
Women:	No.	698	406	197	63	18	1104	278	1382
	Population*	910	705	455	215	80	1615	750	2365
	Per cent of population	77	58	42	29	23	69	37	58
Total no.		1205	631	290	101	27	1836	418	2254

* Population of East Kilbride at 1971 census.

- 3) Records showing clockwise rotation (Code IX.4.2) were divided into those where the transition zone was to the right of lead V₅, and those where it was in lead V₄, between leads V₄ and V₅, or in lead V₅.

Patterns or groups of codings were assigned according to the following definitions:

- 1) *Minor abnormality*: the following, when present alone or in combination with each other: left axis deviation (Code II.1) without left anterior hemiblock; counterclockwise rotation (Code IX.4.1); clockwise rotation (Code IX.4.2), with the transition zone in or to the left of lead V₅; sinus tachycardia (Code VIII.7); sinus bradycardia (Code VIII.8). These codes were ignored when occurring in combination with others.
- 2) *Q/QS patterns*: Codes I.1.1-7 (subdivided into those with these codes alone, those with ST-T changes only, and those with other codes) were termed Q/QS₁ patterns, Codes I.2.1-7 and I.3.1-6 (similarly subdivided), Q/QS₂ and Q/QS₃ patterns, respectively.
- 3) *ST-T patterns*: codes V.1 and V.2, with or without codes IV.1-4 and in the absence of Q/QS or left ventricular hypertrophy patterns were termed major ST-T patterns. Code IV.4 alone and code V.3 with or without codes IV.1-3, and with the same exceptions, were termed minor ST-T patterns.
- 4) *Left ventricular hypertrophy patterns*: high amplitude R waves (codes III.1 and III.3) without ST-T changes were defined as 'possible' left ventricular hypertrophy patterns, and those with ST-T changes (whatever other codes were also present) 'probable' left ventricular hypertrophy patterns (Kannel *et al.*, 1970; Kennedy and Caird, 1972).
- 5) Patterns taken to indicate right ventricular hypertrophy are described in the text.

Results

The frequency of abnormalities codable in the various major groupings of the code are shown in Table 2. No codable abnormality (Code I.0) was present in 910 of the 2254 records (40%), slightly more often in women than in men, and fell sharply in frequency, from 40 to 45 per cent in those aged under 75, to 26 to 29 per cent in those over that age (Table 2).

492 records (22%) showed minor abnormality as defined. Counterclockwise rotation contributed half of these (11%), and clockwise rotation almost a quarter (5%). Left axis deviation was found in 3 per cent. Except that 18 of the 22 subjects with sinus tachycardia were women, no subgroup showed any substantial sex difference, nor were there any clear trends with age. If the subjects with minor abnormality are added to those with no codable abnormality, then 62 per cent of all records may be said to show no significant abnormality.

The Q/QS patterns are detailed in Table 3. Forty two subjects (1.9%) had Q/QS₁ patterns, 64 (2.8%) Q/QS₂ patterns, and 36 (1.6%) Q/QS₃ patterns. Q/QS₁ patterns were present in 4 per cent of men, but only 0.4 per cent of women, without relation to age. By contrast, Q/QS₂ and Q/QS₃ patterns showed a more nearly equal prevalence by sex, and some increase in frequency with age. In about one-quarter of cases Q/QS patterns were associated with patterns other than ST-T in type.

ST-T patterns, apart from those which were part of Q/QS or left ventricular hypertrophy patterns, were found in 293 subjects (13%) (Table 4). Major ST-T patterns were equally common in men and women (5%), and increased in frequency with age. Minor patterns also increased in frequency with age, but were more common in women (9%) than in men (6%).

The frequency of ventricular hypertrophy patterns is shown in Table 5. 'Possible' left ventricular hypertrophy was found in 4 per cent, without great age or sex differences, but 'probable' left ventricular hypertrophy patterns were more frequent in women than in men, and increased in frequency with age, so that they were seen in no less than 10 per cent of women over the age of 75.

Patterns thought to indicate right ventricular hypertrophy were seen in only 16 subjects, 11 of them men under the age of 75 (Table 5). All 16 had cough and/or phlegm for more than three months in

TABLE 2 Frequency of codable abnormalities

Age group Sex		65-74 M F		75+ M F		65+ M F		65+ M+F
Total no.		732	1104	140	278	872	1382	2254
Code								
No codable abnormality	I.0	293	498	36	83	329	581	910
%		40	45	26	29	38	42	40.3
Q/QS patterns	I.1-3	69	37	18	18	87	55	142
%		9	3	13	6	10	4	6.3
QRS axis deviation	II.1-5	99	78	34	37	133	115	248
%		14	7	24	13	15	8	11.0
High amplitude R waves	III.1+3	51	94	7	47	58	141	199
%		7	9	5	17	7	10	8.8
ST junction and segment depression	IV.1-4	34	55	13	37	47	92	139
%		5	5	9	13	5	7	6.2
T wave items	V.1-3	133	197	34	81	167	178	345
%		18	18	24	29	19	13	15.3
AV conduction defects	VI.1-5	5	8	8	4	13	12	25
%		1	1	6	1	2	1	1.1
Ventricular conduction defects	VII.1-6	46	45	16	14	62	59	111
%		7	4	11	5	7	4	4.9
Arrhythmias	VIII.1-8	48	70	17	39	65	109	174
%		7	6	12	14	8	9	7.7
Miscellaneous items	IX.1-5	225	276	36	99	261	365	626
%		31	25	26	31	30	26	27.8

the year, most for many years, and all had substantial reduction in peak expiratory flow rate. Ten had right axis deviation (Codes II.2 or 3), 2 tall P waves (Code IX.3), 3 incomplete right bundle-branch block, and 11 clockwise rotation, with the transition zone to the left of lead V₅ in 5.

There were 21 examples of first degree atrio-ventricular block (0.9%), together with one of 2:1 block (Table 6). One of the three women with a short PR interval (Code VI.5) gave a history suggestive of paroxysmal tachycardia. The commonest variety of ventricular conduction defect was left

TABLE 3 Q/QS patterns

<i>Age group Sex</i>		<i>65-74 M F</i>		<i>75+ M F</i>		<i>65+ M F</i>		<i>65+ M+F</i>	
<i>Total no.</i>		<i>732</i>	<i>1104</i>	<i>140</i>	<i>278</i>	<i>872</i>	<i>1382</i>	<i>2254</i>	
		<i>Code</i>							
Q/QS.1	Alone	I.1.1-7	3	0	1	0	4	0	4
	With ST-T changes alone		19	4	1	0	20	4	24
	With other changes		9	0	4	1	13	1	14
	Total		31	4	6	1	37	5	42
	%		4	0.4	4	0.4	4	0.4	1.9
Q/QS.2	Alone	I.2.1-8	9	5	1	6	10	11	21
	With ST-T changes alone		14	12	4	3	18	15	33
	With other changes		2	3	1	4	3	7	10
	Total		25	20	6	13	31	33	64
	%		3	2	4	5	3	2	2.8
Q/QS.3	Alone	I.3.1-6	6	6	2	2	8	8	16
	With ST-T changes alone		4	3	2	1	6	4	10
	With other changes		3	4	2	1	5	5	10
	Total		13	13	6	4	19	17	36
	%		2	1	4	1	2	1	1.6
Q/QS	Total	I.1-3	69	37	18	18	87	55	142
	%		9	3	13	6	10	4	6.3

TABLE 4 *ST-T patterns*

Age group Sex		65-74 M F		75+ M F		65+ M F		65+ M+F
Total no.		732	1104	140	278	872	1382	2254
Major ST-T patterns	Code							
	V.1 or 2							
	± IV.1-4							
	Alone	23	44	8	18	31	62	93
Minor ST-T patterns	With other changes*	7	6	4	1	11	7	18
	Total	30	50	12	19	42	69	111
	%	4	5	9	7	5	5	5
	Code							
Major ST-T patterns	V.3 ± IV.1-3							
	or IV.4							
	Alone	37	80	11	26	48	106	154
	With other changes*	8	13	0	7	8	26	28
Minor ST-T patterns	Total	45	93	11	33	56	126	182
	%	6	8	8	12	6	9	8

* Excluding subjects with Q/QS or left ventricular hypertrophy patterns.

anterior hemiblock, which was present in 51 subjects (2%), 15 of whom also had right bundle-branch block (Table 6). Left anterior hemiblock was commoner in men than women. Complete left bundle-branch block was found in 31 subjects (1.4%), again more commonly in men, and complete right bundle-branch block in 40 (1.9%). There were 32 examples of incomplete right bundle-branch block (1.4%), 11 of intraventricular block, and 7 of incomplete left bundle-branch block.

The only arrhythmias commonly observed were frequent ectopic beats (defined as more than 4 ectopic complexes in 40), and atrial fibrillation (Table 7). Sixty-nine subjects (3%) had frequent ectopic beats, which were atrial in origin in 31, ventricular in 27, nodal in 3, and mixed in 8. Atrial

fibrillation was present in 2 per cent of records from subjects under 75 and 5 per cent over that age. Six examples of low atrial or coronary sinus rhythm (Code VIII.6) were encountered.

Thirty-three subjects showed a variety of miscellaneous abnormalities occurring in isolation. These include one possible example of left posterior hemiblock (Code II.3), 14 of low amplitude QRS complexes (Code IX.1), 3 each of ST segment elevation (Code IX.2), and tall T waves (Code IX.5), 6 of tall P waves of 'P pulmonale' type (Code IX.3; 4 of these subjects had chronic bronchitis), and finally 5 with clockwise rotation with the transition zone to the left of lead V5 (Code IX.4.2), without obvious explanation, such as anterior infarction, right ventricular hypertrophy, or left anterior hemiblock.

TABLE 5 *Ventricular hypertrophy patterns*

Age group Sex		65-74 M F		75+ M F		65+ M F		65+ M+F
Total no.		732	1104	140	278	872	1382	2254
Left ventricular hypertrophy	Code							
	III.1 or 3							
	'Possible' Alone	22	39	3	13	25	52	77
	With other change	8	6	0	5	8	11	19*
	Total	30	45	3	18	33	63	96
	%	4	4	2	6	4	5	4
	'Probable' Alone	15	43	1	22	16	65	81
	With other change	6	6	3	7	9	13	22†
	Total	21	49	4	29	25	78	103
	%	3	4	3	10	3	6	5
Possible right ventricular hypertrophy	Total	51	94	7	47	58	141	199
	%	7	9	5	17	7	10	9
	Total	11	4	1	0	12	4	16
	%	2	0.4	0.7	0	1	0.3	0.7

* 3 with Q/QS patterns.

† 9 with Q/QS patterns.

TABLE 6 Conduction defects

<i>Age group</i> <i>Sex</i>		<i>65-74</i> <i>M F</i>		<i>75+</i> <i>M F</i>		<i>65+</i> <i>M F</i>		<i>65+</i> <i>M+F</i>		
<i>Total no.</i>		<i>732</i>	<i>1104</i>	<i>140</i>	<i>278</i>	<i>872</i>	<i>1382</i>	<i>2254</i>		
Atrio-ventricular	{	1st degree atrioventricular block	VI.3	5	4	8	4	13	8	21
		Other	VI.2 and 5	0	4	0	0	0	4	4*
	{	Left bundle-branch block	VII.1	12	13	2	4	14	17	31
		%		2	1	1	1	2	1	1
		Right bundle-branch block alone	VII.2	8	10	3	4	11	14	25
		Right bundle-branch block with left anterior hemiblock	II.1, VII.2	8	1	5	1	13	2	15
		Total		16	11	8	5	24	16	40
Ventricular	{	%		2	1	6	2	3	1	2
		Left anterior hemiblock	II.1	18	7	4	7	22	14	36
		%		2	1	3	2	3	1	2
		Incomplete left bundle-branch block	VII.6	2	3	1	1	3	4	7
		Incomplete right bundle-branch block	VII.3	12	16	2	2	14	18	32
		%		2	1	1	1	2	1	1
		Intraventricular block	VII.4	4	2	3	2	7	4	11

* 1 case of 2:1 atrioventricular block, and 3 of short PR interval. Subjects with other abnormalities included.

Discussion

The subjects of this study comprise a proportion of the total elderly population of East Kilbride, which declines with age (Table 1). The likely reasons for this are the continuing recruitment into the screening programme of people reaching the age of 65, and the selective exclusion of those old people who are unable or unwilling to attend for examination at a clinic; these are likely to be more frequent in the older age groups. Thus, though other more truly random samples of the elderly population (Kennedy and Caird, 1972; Kitchin *et al.*, 1973) may reflect

the overall prevalence of electrocardiographic abnormalities more accurately, there can be little reason to doubt that the present subjects represent the healthier part of the elderly population.

Comparison between the findings of the present study and those of others is greatly simplified by considering principally those in which the Minnesota Code has been employed (Table 8), but there remain difficulties, especially when the problems raised by multiple codes have been solved differently by different workers. Even the definition of normality varies. The frequency of 'no codable

TABLE 7 Arrhythmias

Age group Sex		65-74 M F		75+ M F		65+ M F		65+ M+F
Total no.		732	1104	140	278	872	1382	2254
Atrial fibrillation	Code							
	VIII.3	11	20	7	13	18	33	51
Frequent ectopic beats	%	2	2	5	5	2	2	2
	VIII.1	27	21	8	13	35	34	69*
Coronary sinus rhythm	%	4	2	6	5	4	3	3
	VIII.6	1	2	1	2	2	4	6(0.3%)

* Atrial in 31, nodal in 3, ventricular in 27, and mixed in 8. Subjects with other abnormalities included.

TABLE 8 Prevalence of electrocardiographic abnormalities in old people at home

Study	Ostrander et al. (1965)*	Edmands (1966)	Kennedy and Caird (1972)*	Kitchin et al. (1973)*	This study*
Age No. of subjects	60+ 603	52+ 1560	65+ 400	62+ 482	65+ 2254
No codable abnormality	—	—	43%†	44%†	40%‡
Q/QS patterns	7%	—	10%	8%	6%
T wave items	32%	—	11%	27%	15%
Left bundle-branch block	1.7%	1.4%	2.5%	0.6%	1.4%
Right bundle-branch block	2.0%	2.0%	3.5%	2.3%	1.9%
Incomplete right bundle-branch block	1.7%	—	3.0%	1.5%	1.5%
Atrial fibrillation	2.4%	—	3.0%	2.5%	2.0%

* Minnesota code employed.

† Includes positional changes only.

‡ Excludes positional changes only.

abnormality' cannot be determined from the data of Ostrander *et al.* (1965), while the apparent agreement between the other three studies shown in Table 8 is in fact spurious, since 'no codable abnormality' in the present study includes only Code I.o, and in those of Kennedy and Caird (1972) and Kitchin *et al.* (1973) also includes codes for positional changes, which are present in over 20 per cent of cases.

There is, however, good agreement between the various investigations on the prevalence of Q/QS abnormalities, which are found in 6 to 10 per cent of records (Table 8). All find them more common in men than in women, but the remarkable difference in prevalence by sex between Q/QS1 patterns on the one hand, which are 10 times more frequent in men in the present study (Table 3), and Q/QS2 and 3 patterns on the other, in which the sex ratio is very much less, does not seem to have been remarked on previously. A further striking difference is seen in the prevalence of ST-T abnormalities that were found in about 30 per cent of elderly people by Ostrander *et al.* (1965) and Kitchin *et al.* (1973), but in only half that proportion by Kennedy and Caird (1972) and in the present study. All four studies find ST-T patterns more common in women than in men, especially T wave flattening (Code V.3), and show an increase in frequency with age. The reason for the twofold difference in total prevalence is uncertain.

The most frequent conduction defect found in the present study is left anterior hemiblock, which was present in 2 per cent of all records, including about one-third of those with complete right bundle-branch block, as Edmands (1966) also found. It has been stated that left bundle-branch block is more common in the elderly than right bundle-branch (Bjornberg, 1960), but all five investigations

cited in Table 8 show the reverse to be true. Bjornberg studied hospital patients, and it is likely that left bundle-branch block is more often associated than right bundle-branch block with severe and symptomatic heart disease in old age, and thus tends to be over represented in a hospital population.

The frequency of first degree atrioventricular block (0.9%) is of the same order as that found by Hiss and Lamb (1962) in younger people (0.65%), while to find only one subject with a higher degree of block among 2000 old people is not unexpected, since Shaw and Eraut (1970) give a prevalence of 1 per 1000 over the age of 75, and less than half that figure for ages between 65 and 75, for second and third degree heart block together.

Kannel *et al.* (1970) suggested that left ventricular hypertrophy patterns should be divided into 'possible', when only voltage changes are present, and 'definite' or 'probable', when ST-T changes are also seen. When this distinction is applied to the elderly (Kennedy and Caird, 1972) 'possible' left ventricular hypertrophy shows little sex or age difference, while 'probable' left ventricular hypertrophy is found more commonly in women, especially over the age of 75 (Table 5). This presumably principally reflects the higher mean blood pressure of elderly women (Hamilton *et al.*, 1954; Master, Lasser, and Jaffe, 1958; Anderson and Cowan, 1959), though 'probable' left ventricular hypertrophy patterns are not infrequently encountered in clinical practice in elderly women who have no past or present evidence of a rise in blood pressure, nor of valvular disease such as aortic stenosis.

The Minnesota Code does not provide adequately for the identification of right ventricular hypertrophy, particularly that accompanying airways obstruction (which is by far the commonest variety in old age (Kennedy and Caird, 1972)), when high

amplitude R waves in the right praecordial leads are distinctly rare (Caird and Wilcken, 1962). The most satisfactory criteria are probably those of Goodwin and Abdin (1959), but these require the recording of lead V₄R, without which one-third of cases of right ventricular hypertrophy in airways obstruction will be missed (Caird and Wilcken, 1962). There is, however, little doubt that the great majority of the 16 cases recorded in Table 6 as having right ventricular hypertrophy would have satisfied the criteria of Goodwin and Abdin (1959). The striking preponderance of right ventricular hypertrophy in men parallels the much greater prevalence of chronic bronchitis in elderly men (Caird and Akhtar, 1972), while its rarity over the age of 75 reflects the poor prognosis of chronic pulmonary heart disease in old age (Bedford and Caird, 1956).

Atrial fibrillation is found in 2 to 3 per cent of electrocardiograms of old people at home (Table 8), with little sex difference, but an increase with age (Table 7). In elderly patients in hospital the prevalence is around 15 per cent (see Bedford and Caird, 1960)—a striking example of the difference between the two population groups.

Ectopic beats are very often seen in standard electrocardiograms in old age, but their frequency relatively rarely reaches 1 in 10 complexes, the figure needed for them to be recorded under the Minnesota Code. They are encountered at this frequency in only 3 per cent of records (Table 7) with little sex difference and a small increase with age. The relative frequencies of ectopic beats of atrial and ventricular origins is as previously found (Kennedy and Caird, 1972). The detection of a small number of cases of coronary sinus rhythm (0.3%) is of interest; the prevalence is of the same order as Hiss and Lamb (1962) found in younger people (0.55%). Clinical impression supports their view that this is a benign arrhythmia at any age.

In conclusion, this study shows that the electrocardiogram is entirely normal in 40 per cent of old people, and that only minor abnormalities are present in a further 22 per cent. Separate assessment is needed of the significance of each of the definite abnormalities shown in the remainder, and the second paper in this series will attempt this.

Our thanks are due to the general practitioners of East Kilbride for permission to study patients under their care, to the staff of the Department of the Medical Officer of Health for their untiring assistance with the records, and to Dr. R. D. Kennedy for advice and criticism.

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