Prevalence of normal electrocardiograms in primary care patients

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Summary

Objective: Knowing the proportion the proportion of normal and abnormal electrocardiograms (ECGs) in primary care patients allows us to estimate the proportion of exams that can be analyzed by the general practitioner with minimal training in ECG interpretation, in addition to being epidemiologically relevant. The objective of this study is to assess the prevalence of normal ECGs in primary care patients.

Methods: all digital ECGs analyzed by the cardiologists of Telehealth Network of Minas Gerais (TNMG) in 2011 were evaluated. TNMG is a public telehealth service that provides support to primary care professionals in 662 municipalities in the state of Minas Gerais, Brazil.

Results: during the study period, 290,795 ECGs were analyzed (mean age 51 ± 19 years), 57.6% were normal. This proportion was higher in women (60.1 vs 57.6%, p <0.001) and lower in patients with hypertension (45.8% vs 63.2%, p <0.001) or diabetes (43.3% vs 63.2%, p <0.001). A progressive reduction in the prevalence of normal ECG with increasing age was observed. Among the ECGs of patients under investigation for chest pain, 58.7% showed no abnormalities.

Conclusion: the prevalence of normal ECGs in primary care patients is higher than 50% and this proportion decreases with age and comorbidities. Most ECGs performed for investigation of chest pain in primary care shows no abnormality.

Uniterms: electrocardiography, telemedicine, primary health care.

Introduction

The electrocardiogram (ECG) is a method of investigation of the cardiovascular system with established prognostic and diagnostic value, easy to perform, has low cost and great clinical utility.[1]

The progressive development of electrocardiographic recording and transmission equipment, incorporating miniaturized and resistant electronic circuits, has led to the development of digital ECG that once connected to the internet, enables the transmission of the signal in real time for remote analysis.[2]

The Telehealth Network of Minas Gerais (TNMG) is a public telemedicine service that serves more than 850 primary care units in 662 municipalities in Minas Gerais, Brazil, covering 47.2% of the state population, approximately 9,265,820 inhabitants. The Network offers tele-electrocardiography and teleconsultation services. The tele--electrocardiography service provides support for primary care physicians through the transmission of digital ECG and case discussion in real time with cardiologists. There are benefits such as reducing the number of referrals and identifying patients who need urgent care.[1,3,4]

This service is fully integrated into the health system of all municipalities and is very successful, having performed over 1,700,000 ECG reports, which currently corresponds to an average of 1,700 exams per day. Given the large number of tests performed, the analysis of ECGs can allow the knowledge of the proportion of normal and abnormal ECGs in primary care patients. In addition to

having great epidemiological relevance, these data allow us to estimate the proportion of patients with ECGs that could be analyzed by general practitioners with minimal training in ECG interpretation, and also help estimate the percentage of patients who require further investigation.

Thus, the aim of this study is to evaluate the prevalence of ECGs without abnormalities in primary care patients in Minas Gerais, Brazil, considering the tests analyzed by cardiologists of the tele-electrocardiography service.

METHODS

ECGs are performed in the places of origin and transmitted by remote teams over the Internet to the RTMG analysis center. In the analysis center, the exams are immediately directed the team of cardiologists, who are professionals trained and experienced in ECG analysis and interpretation. These professionals issue a report, using standardized criteria,[5] which is accessed at the source. Measures to ensure the quality of the service include periodic discussion of diagnostic criteria and periodic audits in the ECG reports.

This observational and retrospective study included all examinations using digital 12-lead electrocardiogram analyzed by cardiologists of the TNMG in 2011. The prevalence of normal ECGs was evaluated.

Statistical analysis was performed using SPSS software (SPSS Inc., Chicago, IL) version 18.0. Categorical variables were expressed as counts and percentages, and chi-square test was used to compare the prevalence of ECG without change according to comorbidities. A p value of 0.05 was considered statistically significant, and all p values are two-tailed.

This study was approved by the Ethics and Research Committee of the Federal University of Minas Gerais, with issuance of opinion ETIC 0072.0.203.00-11.

RESULTS

During the study period, a total of 290,799 ECGs were evaluated, and 273,070 (93.9%) were performed in primary care units in the countryside of Minas Gerais and 17,729 in primary care units of the state capital, Belo Horizonte (6.1%). The mean age was 51 ± 19 years, ranging from 1 to 105 years; 59.3% were women. The clinical characteristics of these patients are summarized in Table 1. Hypertension was the most common comorbidity.

Regarding the tests requested in the countryside, the median of the population of the municipalities that requested analyses of tests was 8,924 inhabitants (interquartile range 5.225 to 14.592). Tables 2-4 summarize demographic

information from requesting municipalities. It should be noted that most of ECGs were originated from municipalities with fewer than 10,000 inhabitants. Regarding the 10 municipalities that requested the highest number of ECGs (7.6% of the total), all of them are located more than 250 kilometers from the capital, 9 have HDI bellow the state average and GDP per capita less than half of the state average. In addittion, they have a higher proportion of poor and extremely poor people and a higher rate of illiteracy compared to the state average. Eight of them are situated in the northern region of Minas Gerais, in the mesoregion where nearly a quarter of exams were originated from.

TABLE 1 Clinical characteristics of primary care patients who underwent electrocardiography using the service of the Telehealth Network of Minas Gerais in 2011 (N=290,799)

Clinical characteristics	N (%)
Hypertension	94378 (32.5)
Family history of coronary artery disease	43645 (15.0)
Smoker	20618 (7.1)
Diabetes mellitus	15963 (5.5)
Chagas disease	8795 (3.0)

TABLE 2 Number of electrocardiograms requested according to population group of municipalities

Population range*	ECGs requested N (%)	N total municipalities in the state	Municipalities assisted by the TNMG N (%)**
0 to 3,500	22334 (8.18)	108	107 (16.2)
3,501 to 7,000	83256 (30.49)	275	266 (40.2)
7,001 to 14,000	94271 (34.52)	208	188 (28.4)
14,001 to 28,000	40909 (14.98)	146	64 (9.7)
28,001 to 42,000	19694 (7.21)	40	20 (3.0)
42,001 to 98,000	12513 (4.58)	47	14 (2.1)
98,001 to 266,000	87 (0.03)	20	2 (0.3)
266,001 to 532,000	6 (0.00)	6	1 (0.01)
>532 thousand	-	3	0 (0.01)
Total	273070***	853	662

TNMG: Telehealth Network of Minas Gerais
* Brazilian Census Bureau, IBGE/2010
** Percentage of total municipalities assisted by the TNMG
*** This does not include the Basic Health Units in Belo Horizonte

TABLE 3 Characteristics of the ten municipalities that requested the highest number of electrocardiograms * from January to December 2011 compared to Belo Horizonte, Minas Gerais and Brazil

Municipality	Population (IBGE/2010)	ECGs N (% of 2011's total)	Distance from the capital	MHDI (UNDP (2010)**	GDP per capita	Mesoregion	% of poor people***	% of extremely poor people****	Illiteracy rate *****
São Francisco	53,828	3,686 (1.3%)	658 km	0.638	4880.25	Northern Minas	37.96	15.88	23.67
Pirapora	53,368	2,526 (0.9%)	340 km	0.731	19756.77	Northern Minas	13.06	2.91	8.99
Mirabela	13,042	2,274 (0.8%)	483 km	0.665	4822.54	Northern Minas	29.25	10.93	22.35
Bocaiúva	46,654	2,259 (0.8%)	369 km	0.700	8807.16	Northern Minas	20.13	6.24	16.38
Turmalina	18,055	2,073 (0.8%)	480 km	0.682	7059.94	Jequitinhonha	19.79	7.76	19.84
Espinosa	31,113	2,038 (0.7%)	699 km	0.627	5006.30	Northern Minas	29.03	12.73	30.81
Porteirinha	37,627	1,871 (0.7%)	591 km	0.651	4679.57	Northern Minas	32.00	14.33	27.40
Janaúba	66,803	1,850 (0.7%)	540 km	0.696	7854.37	Northern Minas	18.98	4.07	18.75
Buenópolis	10,291	1,813 (0.7%)	272 km	0.669	7333.30	Central Minas	20.62	7.80	19.80
Varzelândia	19,116	1,709 (0.6%)	590 km	0.594	4631.76	Northern Minas	43.84	22.81	33.46
Belo Horizonte	2,375,151	--	--	0.810	21748.25	--	3.80	0.79	3.45
Minas Gerais	19,383,604	--	--	0.731	17931.89	--	10.97	3.49	10.36
Brazil	190,755,799	--	--	0.727	19766.33	--	15.2	6.62	11.82

* This table does not include the primary care units in Belo Horizonte
**Municipal Human Development Index. Geometric mean of indexes for income, education and longevity dimensions with equal weights.
*** Proportion of individuals with per capita household income equal to or less than BRL 140.00 monthly, in August 2010. The universe of individuals is limited to those living in permanent private households.
**** Proportion of individuals with per capita household income equal to or less than BRL 70.00 monthly, in August 2010. The universe of individuals is limited to those living in permanent private households.
***** Ratio of the population aged 25 or older who cannot read or write a simple note and the total of people in this age group multiplied by 100.

Regarding the reason for requesting the ECG, a sample of examinations conducted in January 2011 was evaluated: among the 19,370 examinations, 13,679 were performed to investigate chest pain (70.6%) and in 4298 examinations (22.2%) the reason was not explained. Among the remaining 1483 (7.2%), the most common reasons reported by the applicant were periodic health assessment (38.8%), preoperative evaluation (19.5%), clinical evaluation (15.9%), evaluation of a patient complaining of palpitations (6.2%), monitoring of patients with Chagas disease (3.8%), evaluation and monitoring of patients using N-methylglucamine antimoniate (3.8%).

Among the exams evaluated, 57.6% had no abnormalities. This proportion was higher in women (60.1% *vs.* 53.8%, p<0.001). Progressive reduction in the prevalence of normal examinations was seen with increasing age (Figure 1), as well as significant negative correlation between age and the proportion of normal ECGs (Spearman correlation coefficient -0.33, p <0.001).
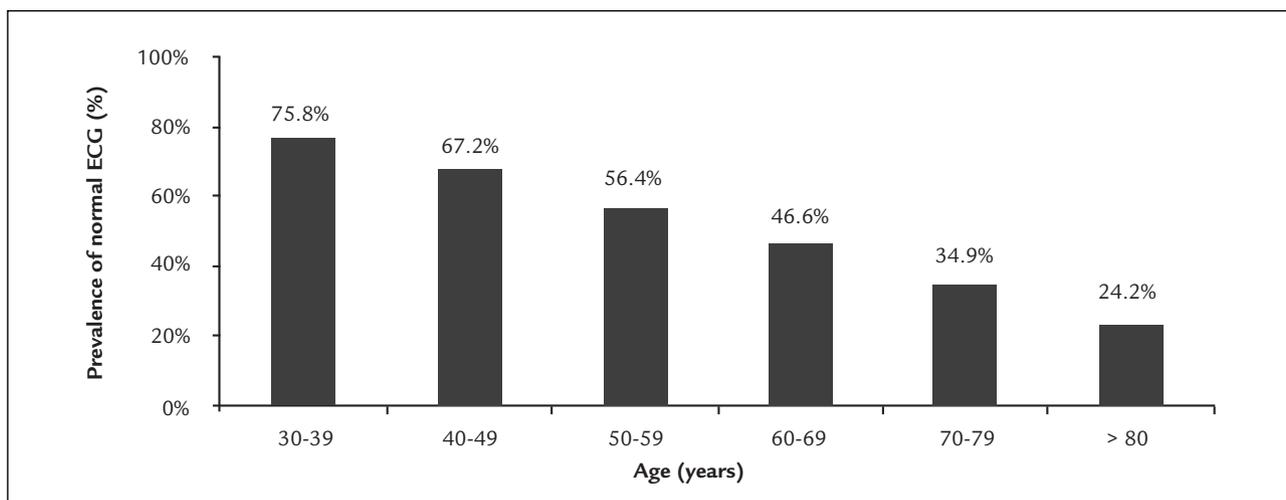
In addittion, the prevalence of normal ECGs was lower in patients with hypertension (45.8% *vs.* 63.2%, p<0,001) and diabetes (43.3% *vs.* 58.4%, p<0.001). As expected, the prevalence was also lower in patients with a history of previous myocardial infarction (31.1%) and

TABLE 4 Number of electrocardiograms requested according to mesoregions in Minas Gerais

Mesoregion	Total ECGs N (%)	N total municipalities in the state	Municipalities in the TNMG N (% of the state's total)	GDP per capita**	HDI**	Normal ECGs
Northern Minas	64.693 (23.7)	86	86 (100)	6634.27	0.647	56.7
Belo Horizonte's metropolitan area*	29.411 (10.8)	103	65 (63.1)	18364.98	0.676	55.5
Zona da Mata	27.791 (10.2)	94	84 (89.4)	9382.50	0.672	59.5
Southern / Southwestern Minas	24.582 (9)	153	96 (62.7)	13900.36	0.685	59.3
Vale do Mucuri	23.409 (8.6)	63	62 (98.4)	6042.47	0.633	58.9
Campo das Vertentes	20.555 (7.5)	51	45 (88.2)	10907.72	0.667	57.0
Vale do Rio Doce	19.073 (7)	85	68 (80)	7592.37	0.652	61.5
Central Mineira	15.316 (5.6)	52	43 (82.7)	8088.59	0.647	59.4
Jequitinhonha	14.886 (5.5)	23	23 (100)	5956.93	0.648	55.4
Western Minas	11.220 (4.1)	56	41 (73.2)	14283.41	0.691	59.2
Northwest	7.324 (2.7)	33	22 (66.7)	15077.62	0.671	55.0
Triângulo Mineiro and Alto Paranaíba	14.810 (5.4)	54	27 (50)	27965.75	0.698	56.0
Total	273070					

* This figure does not include the primary care units in Belo Horizonte
ECGs: electrocardiograms
** Arithmetic mean of the GDP per capita. and MHDI of the municipalities in each mesoregion

FIGURE 1 Prevalence of normal electrocardiograms according to age group.

Chagas disease (28.5%), which is still an endemic disease in South American countries.[6]

Furthermore, a variation of the proportion of normal ECGs was observed, ranging from 55.0 to 61.5%, depending on the mesoregion where the exam originated from. (Table 4).

Regarding the ECGs requested to investigate chest pain, (n=218, 081), the mean age of patients was 51 ± 19 years, 59.1% were women. No abnormality was observed in 58.7% of the exams.

DISCUSSION

This is the first study to assess the prevalence of normal ECGs exclusively in primary care patients. It was based on the analysis of a large database of a telehealth service fully integrated to the cities' primary care service and found that, in this group of patients, over 50% of all exams have no abnormality. This finding is very important because it suggests that general practitioners with minimal training in ECG interpretation can analyze most ECGs of primary care patients, especially patients without comorbidities.

Giuliano et al. assessed the prevalence of electrocardiographic abnormalities in a telemedicine service database from the State of Santa Catarina and observed a prevalence of normal ECGs significantly lower than in the present study (47.2% *vs.* 57.6%),[7] because there was no restriction of evaluation for primary care patients (72.0% primary, 22.0% secondary and 6.0% tertiary),[7] which would explain the higher prevalence of abnormal results.

Furthermore, this study shows the importance of a telecardiology service for the recognition of important conditions to health policies. The recognition of the importance of chronic diseases on morbidity and mortality in Brazil prompted the Ministry of Health (MH) to create, in 2011, the *"Plano de Ações Estratégicas para o Enfrentamento das Doenças Crônicas Não Transmissíveis"*, an action plan to reduce the impact of chronic non-communicable diseases, in which the patient's integral care is a mainstay.[10,11] To meet this guideline, the MH created *"Rede de Atenção às Pessoas com Doenças Crônicas"*, a system of care for people with chronic diseases, establishing primary care as an ordering instance of the network and care coordinator. The system of care's need to count on proper diagnostic support and use the telehealth systems as qualification tools for management is also recognized.[12]

Therefore, when the telemedicine service is integrated into the health system, as in this case, the results of analysis of digital ECG may have an important role in planning public health, and knowing the proportion of normal results can guide training strategies in electrocardiography. The ideal strategy would be the training of primary care physicians for recognizing normal ECGs, as well as the most common abnormal electrocardiographic patterns, using remote analysis in cases of more complex traces.

Despite the fact that complaints of chest pain are common in primary care, acute coronary syndrome is a rare cause of chest pain in this population.[8, 9] In the present study, 58.7% of the ECGs of patients being investigated for the cause of chest pain showed no abnormalities. In this case, physicians should be aware of the possibility of acute coronary syndrome with normal ECG, and the importance of careful assessment of clinical symptoms as well as performing serial ECGs in suspected cases.

This study has certain limitations. Only the prevalence of normal ECGs was evaluated without specifically assessing the frequency of specific abnormalities, which will be the subject of further studies. The electrocardiographic reports followed predetermined standards, using criteria defined by the Brazilian Society of Cardiology. These criteria have not been validated in prospective population studies, such as the Minnesota code (13). Intra- and interobserver variability were not studied either. Nevertheless, the criteria used reflect the current practice in the country, ensuring the possibility of generalizing the results to other primary health care settings in Brazil.

CONCLUSION

This study showed that in primary care patients, normal ECGs represent over 50% of all the exams. This prevalence decreases with age and comorbidities. Furthermore, it was observed that most ECGs performed to investigate chest pain in primary care setting showed no abnormalities.

RESUMO

Prevalência de eletrocardiogramas normais em pacientes da atenção primária

Objetivo: o conhecimento da proporção de eletrocardiogramas (ECG) normais e alterados em pacientes atendidos na atenção primária permite estimar a proporção de exames que pode ser analisada pelo médico generalista com formação mínima na interpretação do ECG, além de ter relevância epidemiológica. O objetivo deste estudo é avaliar a prevalência de ECG sem alterações em pacientes atendidos na Atenção Primária.
Métodos: todos os ECG digitais analisados pelos cardiologistas da Rede de Teleassistência de Minas Gerais (RTMG) no ano de 2011 foram avaliados. A RTMG é um serviço público de telessaúde, que atende a atenção primária em 662 municípios em Minas Gerais, Brasil.
Resultados: no período do estudo, 290.795 ECG foram analisados (idade média 51±19 anos) e 57,6% deles eram normais. Essa proporção foi maior em mulheres (60,1 *vs.* 57,6%, p < 0,001) e menor em pacientes com hipertensão (45,8% *vs.* 63,2%, p < 0,001) ou diabetes (43,3% *vs.* 63,2%, p < 0,001). Foi observada redução progressiva na prevalência de ECG normal com o aumento da idade. Entre os ECG de pacientes em investigação para dor torácica, 58,7% não apresentaram alterações.
Conclusão: a prevalência de ECG normais em pacientes da atenção primária é superior a 50% e essa proporção diminui com a idade e a presença de comorbidades. A maioria dos ECG realizados para investigação de dor torácica na atenção primária não tem alterações.

Unitermos: eletrocardiografia; telemedicina; atenção primária à saúde.

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