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Electrocardiogram and Chest Pain in Real Practice: A Retrospective Cohort Study in Family Practicein Portugal

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Abstract: Electrocardiogram (ECG) plays a major role in the study of chest pain. To measure the impact of making an ECG in patients with Chest Pain (CP) in primary care. We conducted a retrospective cohort study of patients with CP that made an ECG in a primary care setting by comparison with those who made the ECG as a routine test in order to measure the change of cardiovascular clinical guidance up to 6 months after ECG. Cases were categorized in atypical or typical CP. Secondary a clinical practice analysis was performed, counting the number of medical visits 12 months before and after ECG. We studied 480 patients, consecutively selected during 4 years, 333 in CP group (286 with atypical CP) and 147 controls. Patients with typical CP presented higher changing in clinical guidance (RR = 4.299; 95% CI: 2.378-7.772, p<0.001) than patients with atypical CP (RR = 1.116; 95% CI: 1.008-1.235, p = 0.047) when compared with controls. In the routine group, there wasn't any variation of visits counting as in the typical CP group but a reduction of 0.59 visits (95% CI: -0.90-0.29; p<0.001) occurred in the atypical CP patients 1 year after the ECG. Anxiety was significantly associated to atypical CP orientation.

Key words: Chest pain, primary care, electrocardiography, physician's practice patterns, disease management, health impact assessment

INTRODUCTION

Chest pain is a common symptom in primary care practice. During lifetime, 20-40% of patients present at least one episode (Ruigomez *et al*., 2006). It counts for 6% of emergency rooms visits (Goodacre *et al*., 2005) and for 1-3% of patients who call for their doctor (Bosner *et al*., 2010). The main cause is musculoskeletal pain from chest wall, counting for more than one third of total followed by ischemic cardiac pain and gastroenterological motives (Ebell, 2011). Psychological causes, unspecific or without a clear diagnosis justify 16-23% of cases.

If the clinical presentation points to an ischemic cause, the Electrocardiogram (ECG) is an unavoidable test but there's few evidence for its realization if another etiology is suspected, making it questionable (Mant *et al*., 2004) or even unjustified. Nevertheless, patients' expectations about their visits to a doctor are established by several personal, familiar and social determinants which may change in a significant way the medical approach both in the semiology as in the evaluation with impact on medical decision (Hani *et al*., 2007).

In this way, we may understand that a chest pain episode may be attributed to the heart, making a test to check for it, even if clinics points to non-cardiac causes (Chambers and Bass, 1998). The Bayes' theorem tells us that if the probability a priori of disease is low, the test's accuracy for the diagnosis tends to lower: the efficacy of making an ECG in a patient with low probability of coronary diseases is low. That's the basis for decision making processes about several clinical conditions and management of diagnostic tests.

Nevertheless, ECG is still asked even in patients with chest pain and low clinical suspicion of coronary disease, the so-called atypical chest pain where the validity of the test is not studied.

The aim of this study is to measure the change in the management of patients with chest pain after making an ECG in primary care.

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MATERIALS AND METHODS

A retrospective cohort study was conducted in patients with chest pain that made an ECG in a primary care setting by comparison with those who made the ECG as a routine test.

Electrocardiograms: The electrocardiograms were collected from the clinical files of patients attended in the health centre of "S. Joao" that offers medical support to a population of 20.000 people in an urban area of North of Portugal. They were performed in the facilities of the health centre by trained nurses, using an electrocardiograph Cardiet start 100 H in the standard 12-leads with the patient in a supine position and in a quiet and air-conditioned environment, at the velocity of 25 mm sec^{-1} and a sensitivity of 10 mm mV^{-1}. Novacode criteria (Rautaharju *et al*., 1998) were used to categorize them in normal with minor abnormalities and with major abnormalities. When ECG was regarded as urgent, nurses were called and tests were made forthwith.

Patients' selection: Patients were included if they made an ECG for chest pain related to heart, according the code K01 from 2°. Edition of International Classification of Primary Care (ICPC-2), consecutively between 01/03/2007 and 31/05/2011 as recorded in electronic clinical files. The controls were the patients that made an ECG for routine in the same period in whom the test has a low impact (Lesho, 2003). Routine tests were defined as those requested in the global health examination visit, without a clinical suspicion to motivate it.

Patients with chest pain were further divided according to the characteristics of pain in patients with typical or atypical chest pain. Chest pain was classified as typical if it had a midsternal location, pressure or heaviness that lasts for 1 h with or without nausea, vomiting or excessive sweating or a patient with a history of angina or myocardial infarction or pulmonary crackles on auscultation, systolic blood pressure <80 mm Hg or presence of third heart sound (Mant *et al*., 2004). A typical chest pain refers to the patient with intermittent or persistent pain located on the left hemithorax, epigastric region, back or limbs but not midsternal and unrelated to exertion or emotions (Weiner *et al*., 1979).

To ensure statistical significance, the sample size was calculated assuming a ratio of amendment to the clinical guidance of 30% in patients with chest pain and 16% in the control group (Rutten *et al*., 2000). For a confidence interval of 95% and a power of 80%, taking into account the distribution of patients in the database, the minimum sample size should be 413 patients, 286 in the group with chest pain and 127 controls.

Outcome: The main outcome was the change of cardiovascular guidance of patients up to 6 months after making the ECG as compared with clinical guidance defined in the last 3 visits before the realization of the ECG. This change was checked by analysis of the prescribed cardiovascular therapy, the application of other diagnostic tests, the referral to hospital care and death.

Secondary a clinical practice analysis was performed, counting the number of medical visits 12 months before and after ECG.

Ethical considerations: Data were collected from electronic clinical files by doctors involved in patients' processes of care. The anonymization was strictly observed, according the helsinki declaration and the oviedo convention of human rights in biomedical research. The protocol had the approval of ethics committee of Sao Joao health centre.

Statistical analysis: We used frequency and dispersion measures for general characterization of sample. Chi-square and Kruskal-Wallis tests were used to check for differences. We calculated the Spearman correlation of distribution of the rations between different analysis groups. Relative risk of change in patients' follow-up was estimated, comparing the groups with and without chest pain. The chest pain group was then categorized in typical and atypical chest pain and relative risk of change was determined. Mantel-Cox regression was used to check for confounding factors of main outcome. We check for normality distribution using Kolmogorov-Smirnov test. Wilcoxon test was used to compare the number of visits 12 months before and after the ECG. An alpha error of 0.05 was accepted. Software IBM SPSS Statistics®, 20th Version was used.

RESULTS AND DISCUSSION

We studied 480 patients (45.2% males). The mean age was 54.0 years (±18.5), 49.1 (±18.7) for males and 58.0 (±17.3) for females. Table 1 shows the general characteristics of sample.

We found differences between routine and chest pain groups. In the group of typical chest pain, patients were mainly women ($p = 0.002$) and older than other groups ($p<0.001$). There's a gradient of prevalence of

Table 1: General characteristics of sample

Samples	Routine n = 147	Atypical chest pain n = 286	Typical chest pain n = 47	p-values	Spearman correlation
Patients	142	271	42		
Male (n, %)	80 (56.3%)	111 (41.0%)	15 (35.7%)	p = 0.002*	
Age (mean, SD)	52.9 (±17.7)	52.4 (±18.7)	67.0 (±14.1)	p<0.001**	
Age quartiles				p<0.001*	0.151§
<42 years (n, %)	44 (35.5%)	77 (62.1%)	3 (2.4%)		
42-57 years (n, %)	42 (33.6%)	73 (58.4%)	10 (8.0%)		
58-68 years (n, %)	29 (25.9%)	73 (65.2%)	10 (8.9%)		
>68 years (n, %)	32 (26.9%)	63 (52.9%)	24 (20.2%)		
Urgency (%)	0.7	21.3	51.1	p<0.001*	0.364§
Comorbidities					
CVRF (%)	49.7	60.1	80.9	p<0.001*	0.166§
HBP (%)	21.8	38.8	68.1	p<0.001*	0.256§
Dyslipidaemia (%)	34.0	42.3	51.1	p = 0.077*	0.103§
DM (%)	2.7	9.4	25.5	p<0.001*	0.198§
Smoking habits (%)	9.5	10.5	12.8	p = 0.817* (NS)	0.026NS
Obesity (%)	11.5	11.5	21.3	p = 0.049*	0.098§
Overweight (%)	33.2	33.2	31.9	p = 0.440* (NS)	0.050NS
Anxiety (%)	31.3	47.9	40.4	p = 0.004*	0.116§
COPD (%)	4.1	1.7	4.3	p = 0.289* (NS)	-0.034NS
CV history	3.4	10.8	34.0	p<0.001*	0.232§
Results					
Normal	65.3	69.2	36.2	p<0.001*	-0.087NS
Minor abnormalities	31.3	34.9	27.6	p = 0.491* (NS)	-0.044§
Major abnormalities	3.4	4.9	36.2	p<0.001*	0.233§

*Chi-square; **Kruskal Wallis test; §p<0.05; CVRF: Cardiovascular Risk Factors; HBP: Arterial hypertension; DM: Diabetes Mellitus; COPD: Chronic Obstructive Pulmonary Disease; CV: Cardiovascular

cardiovascular risk factors between patients in the routine group where it was lower followed by atypical chest pain group and the higher in the typical chest pain group where the urgency on the realization of tests was also more common.

The results of ECG classified by Novacode categories show that patients with typical chest pain present higher proportion of major abnormalities (p<0.001) and less normal tests (p<0.001).

In the group of patients with chest pain, the change in clinical guidance 6 months after making the ECG was 33.9% versus 17.7% in routine group (RR = 1.919; 95% CI: 1.304-2.901; p<0.001).

When we divided the main outcome by the type of change, there was a request of a new diagnostic test in 12.9% in the chest pain group and 10.9% in controls (RR = 1.186; 95% CI: 0.675-2.144; p = 0.533). A change in drug prescription occurred in 9.0% in chest pain group versus 5.4% (RR = 1.655; 95% CI: 0.750-3.861; p = 0.182). A referral to hospital care was verified in 11.1% versus 1.4% in control group (RR = 8.167; 95% CI: 1.990-48.870; p<0.001). Three patients died in chest pain group and none in controls.

Table 2 shows the relative risk of change of the clinical guidance in patients with typical or atypical chest pain by comparison with the routine group. Figure 1 shows the values of relative risk of changing the clinical guidance according the variables with potential impact on medical decision. Mantel-Cox regression was used to

Table 2: Relative risk of changing clinical guidance in patients with atypical or typical chest pain compared to control group, after making an ECG

Risks	Atypical chest pain RR (95% CI)	Typical chest pain RR (95% CI)
Change of clinical guidance	1.116 (1.008-1.235) p = 0.047	4.299 (2.378-7.772) p<0.001
Request of further tests	1.019 (0.949-1.095) p = 0.606	1.047 (0.917-1.195) p = 0.459
Referral to hospital care	1.049 (1.013-1.086) p = 0.027	1.717 (1.342-2.198) p<0.001
Change in drugs prescription	1.021 (0.970-1.074) p = 0.454	1.170 (1.012-1.351) p = 0.004

RR: Relative Risk

multivariate analysis of confounders. In the patients with atypical chest pain, electrocardiographic abnormalities (hazard ratio = 0.433; IC95%: 0.292-0.641; p<0.001) and anxiety (hazard ratio = 1.619; IC 95%: 1.066-2.459; p = 0.024) were significantly associated with change of guidance.

Comparing directly the group of patients with atypical chest pain and typical chest pain, we noticed that the first one showed a minor change in its orientation (RR = 0.324; 95% CI: 0.255-0.412; p<0.001). This result is evident in terms of the referral to hospital care (RR = 0.140; 95% CI: 0.079-0.247; p<0.001) and in the change of drugs' prescription (RR = 0.383; 95% CI: 0.187-0.786; p = 0.009) but not in the request of further tests (RR = 0.845; 95% CI: 0.400-1.787; p = 0.662).

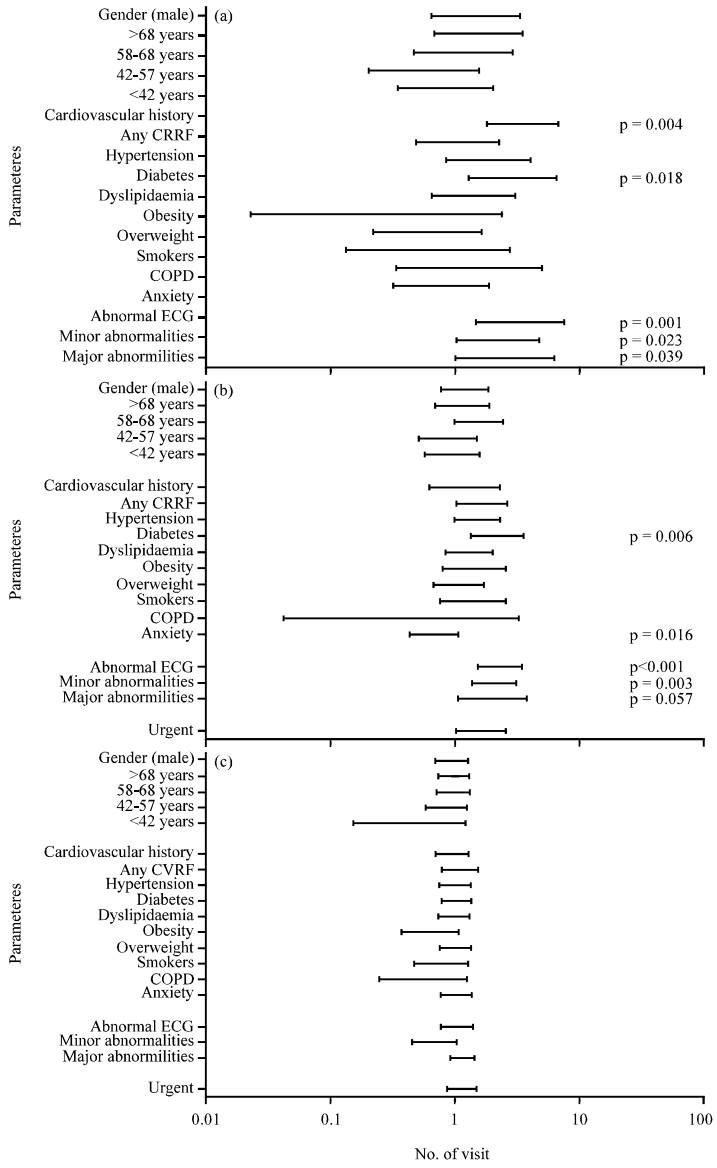

Fig. 1: Relative risk of changing the clinical guidance according the variables with potential impact on medical decision for: a) routine (control) group, b) atypical chest pain group and c) typical chest pain group; CVRF: Cardiovascular Risk Factor; COPD: Chronic Obstructive Pulmonary Disease; ECG: Electrocardiogram

In the analysis of the clinical practice activity, there wasn't any change in the number of visits in the control group 12 months before and after the ECG (variation of -0.14; 95% CI: -0.55-+0.26; p = 0.484). The group with chest pain showed a decrease in number of visits of -0.53 (95% CI: -0.83-0.23; p<0.001). This difference was verified in the group with atypical chest pain where the variation was -0.59 (95% CI: -0.90-0.29; p<0.001) but not in the group with typical chest pain which showed a variation of -0.15; 95% CI: -1.24-+0.94; p = 0.969). Figure 2 shows the mean of number of visits for each group.

Our results show that the patients with chest pain who made an ECG in clinical practice of primary care have twice as likely to see their clinical guidance changed relative to healthy who made an ECG for routine. These results are independent of their age, gender and previous cardiovascular history. Among the cardiovascular risk factors, just diabetes mellitus and obesity proved decisive for the outcome. Rutten *et al.* (2000) found similar conclusions, although other researchers have described a lower impact (Fyfe and Maclean, 1975; Jones, 1984).

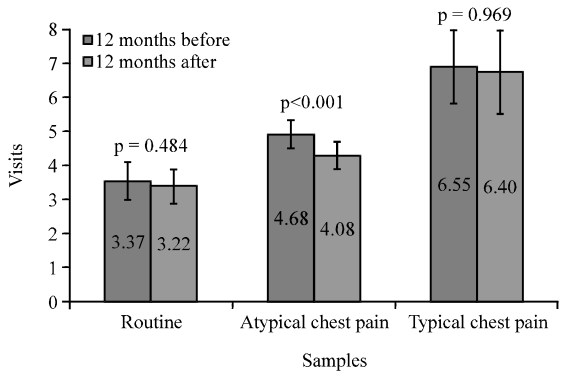

Fig. 2: Distribution of number of visits for chest pain cohort (typical and atypical) and comparison with controls

An important question to discuss is the quality of the available data. Despite the retrospective design of this study, since the outcome is back in time, it has a prospective approach because cases fitting the criteria were included as they became available. The careful and sufficiently objective definition of the kind of pain has sought to mitigate the risk of some facilitation in its categorization. Another problem to point is the heterogeneity of the groups under analysis regarding the basic clinical and demographic characteristics. It derives from the case definition since we compare patients with relevant cardiovascular history to healthy people during routine visits. Differences about age, gender and comorbidities were expected (Richards *et al*., 2000) and it wasn't possible to adjust them in sample selection, making the multivariate analysis required to establish the relative weights. Although, we applied a convenience sampling, its consecutive nature strengthens the representativeness, even because we decided to include all available data, exceeding the minimum sample size. It's possible that some patients were lost in this consecutive series by lack of registry. Although, we can not quantify it, the number is marginal and not likely to call into question the results.

As it was expected, the presence of electrocardiographic abnormalities is determinant for the medical decision. Nevertheless, in patients with chest pain 65% of ECG are normal and just 5 present ischemic abnormalities, 4 in group of typical chest pain. This supports the low profitability of ECG in the study of these patients and it questions the utility of the test in patients with chest pain, particularly if atypical. Mant in 2004, discussed this feature and divided these patients in acute chest pain, where resting ECG and exercise stress test showed obvious advantages and chronic, where heart tests did not prove apparent usefulness (Mant *et al*., 2004).

One part of the answer can be inferred from the direct comparison of patients with typical and atypical chest pain where the key factor for decision making is the presence of anxiety together with an abnormal ECG. This brings to the discussion the need for reassurance that a normal test can strengthen (Van Bokhoven *et al*., 2006) in the context of the continuity of care and the reciprocal familiarity, so characteristic of practice in primary care where slight differences in the behaviour or in the look, many times difficult to quantify, may change the medical approach in the consultation and its final outcome (Hani *et al*., 2007; Olshansky, 2007). This is distinct from the hospital care where procedures are mainly directed for disease management (Eken *et al*., 2006) and less patient centered.

No study until now described an evaluation of clinical practice activity in this context, counting the number of visits around the date of the ECG. This method has the advantage of being objective, reproducible and valid for outcomes' measurement in primary care (Rethans *et al*., 1996), despite the risk of bias to include visits not directly related to the variable studied, since it does not evaluate clinical data. This kind of evaluation seems valid in a situation of open accessibility where patient is the main agent for decision of when to visit a doctor. The choice of a period of 12 months tried to avoid the bias related to the seasonal cycle of care demand.

In our study, patients of routine group did not show differences in the counting of visits before and after making the ECG. The same occurred in the patients with typical chest pain which maintained the pattern of access to their doctors. On the other hand, patients with atypical chest pain had a reduction of 0, 6 visits 12 months after the test. This is consistent with the hypothesis of the ECG have a positive therapeutic effect on reassurance of patients (Mayou, 1998; Sox *et al*., 1981), reflected in the improvement of the demand of health care, even we know that recurrence of chest pain during time is common, varying from 32% in the Framinghan study (Murabito *et al*., 1990) to 83% as described by Eslick and Talley (2008).

In this sense, we can say that for patients presenting in their primary care surgery with chest pain and low probability of coronary disease, the realization of an ECG is reflected in a higher referral to hospital care but does not affect the prescriptionof medicationsor the request of other tests when compared with healthy people. This effect is dependent on psychological factors such as anxiety and in the medium-term, leads to a decrease of office visits. Despite the low profitability of the ECG in terms of abnormalities detected, this aspect integrated in the holistic approach to the patient is indicative of a significant impact on its health status, thus, justifying its

use. These results are relevant for definition of an evidence based practice where the fears and expectations of patients and the expertise of their doctors are integrated in the clinics with the best scientific evidence, thus adding value to the patients to the professionals and to the health system.

CONCLUSION

Making an ECG leads to a higher referral to hospital care but does not affect the therapeutics or the request of other tests in CP patients with a decrease in office visits among those with atypical pain, reflecting a significant impact on its health status, thus justifying its use.

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