Medical History of Coronary Artery Disease and Time to Electrocardiogram in the Emergency Department: A Real-Life, Single-Center, Retrospective Analysis

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Abstract

Background: Timely acquisition of 12-lead Electrocardiogram (ECG) in the emergency department (ED) is crucial and recommended by current guidelines.

Objectives: To evaluate the association of medical history of coronary artery disease (hCAD) on door-to-ECG time in the ED.

Methods: In this single center, retrospective cohort study, patients admitted to ED for cardiac evaluation between were grouped according to hCAD, and no hCAD. The primary outcome was door-to-ECG time. A multivariate analysis adjusted for the cofounders sex, age, type of referral and shift was performed to evaluate the association of hCAD with door-to-ECG.

Results: 1,101 patients were included in this analysis. 362 patients (33%) had hCAD. Patients with hCAD had shorter door-to-ECG time (20 min. [Inter Quartile Range [IQR] 13 – 30] vs. 22 min. [IQR 14 – 37]; p<0.001) when compared to patients with no hCAD. In a multivariable regression analysis hCAD was significantly associated with a shorter door-to-ECG time (- 3 min. [p=0.007; 95% confidence Interval [CI] -5.16 – -0.84 min.]).

Conclusion: In this single center registry, hCAD was associated with shorter door-to-ECG time. In patients presenting in ED for cardiac evaluation, timely ECG diagnostic should be facilitated irrespective of hCAD.

Background

Chest pain is one of the most common causes for referral to emergency departments (ED) worldwide and is challenging through its heterogeneous causes. (1, 2) Simultaneously, limited access to or confidence in primary care and patient perceived urgency cause a trend towards increasing annual ED attendance. (3) This amounts to an increasing number of patients in need of rapid evaluation to determine whether any life-threatening disease for example one of the “big five” of acute chest pain may be present. (4)

In patients with acute myocardial infarction (AMI; “acute myocardial infarction”) a prompt recognition is vital, since the beneficial effects of therapy are greatest when performed soon after symptom presentation. (5–7) Recent clinical evidence emphasize that especially high-risk patients profit from rapid diagnostic and therapy.(8, 9) Therefore, beside clinical history and cardiac markers, early acquisition of a 12-lead electrocardiogram (ECG) in the ED gains importance especially when it comes to the decision for reperfusion therapy. Consequently, a 10 min target for door-to-ECG time is recommended in the majority of national guidelines. Nonetheless, several studies have shown that only one-third of patients with ACS receive ECG acquisition attained the target of 10 minutes after admission. Although societies have made suggestions for performing ECG in the ED, only a minority of the literature addresses how to adhere to the 10 min goal. In the study at hand, we strive to single out clinical factors associated with door-to-ECG time.

Patients with diagnosed coronary artery disease (CAD) have an about 5 to 10 % risk for recurrent cardiovascular events each year and recent guidelines label them to be high-risk patients. (10, 11)

HCAD, is part of several risk scores for risk stratification of patients with chest pain and is among the first clinical data the physician would be confronted with after admission. Therefore we suspected hCAD to influence clinical management. (12–15)

This single-center, retrospective cohort study aimed to evaluate secular trends in ED workflow, comparing patients with hCAD and patients with no hCAD admitted for chest pain evaluation for door-to-ECG time and time from beginning of symptoms to admission and time to coronary angiography (CAG).

Methods

Cohort

In this single center, retrospective cohort study we screened patients admitted to the ED for cardiac evaluation between April and December 2013 for door-to-ECG-time and in a subgroup analysis door-to-CAG-time. Patients were grouped for hCAD, no hCAD and receiving CAG and don't receiving CAG accordingly. The protocol of this study conforms to the ethical guidelines of the 1975 Declaration of Helsinki and was henceforth approved by the institutional ethical committee of university of Freiburg (permit numbers EK99/17).

Outcomes

Primary outcome was the door-to-ECG-time in all included patients. Secondary outcome was the time from initial symptoms to admission and in patients receiving CAG the door-to-CAG-time.

Screening

Full-text keyword-search of the anonymized ED Database segments: key symptoms at admission, anamnesis and diagnosis; was used to single out patients admitted to ED for cardiac evaluation. Keywords included: chest pain; dyspnoea; angina pectoris (AP); retrosternal chest pain; shortness of breath; ST-elevation myocardial infarction (STEMI); non-ST-elevation myocardial infarction (NSTEMI); acute myocardial infarction (AMI); Acute coronary syndrome; myocardial infarction and heart failure.

Patient characteristics and time points

All patient clinical characteristics as well as laboratory data were obtained retrospectively from the hospital's electronic database. Baseline Characteristics include age, sex and cardiovascular risk factors such as pre-existing diagnoses of diabetes mellitus, hypertension, smoking and family with history of cardiovascular disease.

The time points: “start of symptoms”, admission to ED”, “ECG at ED” and “Coronary angiography” were assessed using electronic records or documentation in the hospital database as

Admission process

When a patient with acute chest pain or dyspnoea comes to the ED via self-referral, the patient would be directed to a triage area for a brief registration and anamnesis including the chief complaint before referral to the ED ward and presentation of said symptoms to the doctors by a specialized nurse.

If patients were referred e.g. via the emergency doctor or emergency ambulance, they would arrive directly at the ED ward and the chief complaint would be presented to the medical doctor and nurse in charge of the patients therapy.

Patient presentation independent if from the triage nurse or the emergency services would include sex, age, chief complaint and epitome of the patient history.

If the emergency doctor suspects a transmural myocardial infarction i.e. the patient would be referred directly to the catheter lab for acute coronary intervention bypassing the ED.

Statistical consideration

Continuous patient data were compared using a Mann–Whitney U-test or ordinary one-way ANOVA. Categorical differences between patient groups were compared using Fishers exact test. Continuous variables are presented as median ± lower and upper quartiles. Categorical patient characteristics are presented as percentages. A multivariable median regression model was established to assess influence of a history of CAD on time to ECG. As potential confounders, we took into consideration factors that would be obvious to the caregivers upon patients´ presentation, including sex, age and type of referral. We also checked for differences in time to ECG during the different shifts.

As there was no prespecified plan to adjust for multiple comparisons, 95% confidence intervals were not adjusted for multiple comparisons and inferences drawn from them may not be reproducible. Descriptive analyses were performed using Graph Pad Prism Version 6.0 (Prism 6 for Mac OS X; GraphPad Software, Inc., La Jolla, CA) and multivariable median regressions were conducted using Stata version 16.1 (StataCorp, College Station, Texas).

Results

Baseline Characteristics

1,101 patients met the inclusion criteria. Of those, 362 (34 %) had hCAD and 739 (75 %) had no hCAD. Of those, 351 patients received CAG (172 [49 %] patients with hCAD and 179 [51 %] patients with no hCAD).

Of all included patients, the ones with hCAD were older than patients with no hCAD (74 years [IQR 65 – 82] vs. 60 years [IQR 46 – 74]; $p<0.001$). 31 % in the known-CAD group and 46 % in the no-known-CAD group were female ($p<0.001$).

Compared with patients with no-hCAD, patients with hCAD had higher risk-scores (GRACE score: 125 points [IQR 104 – 147] vs. 93 points [IQR 62 – 125]; p<0.001 and TIMI Score 2 points [IQR 2 – 3] vs. 1 point [IQR 0 – 2]; p<0.001), more cardiovascular risk factors (Diabetes mellitus 28 % vs. 14 %; p<0.001, hypercholesterinaemie 51 % vs. 13 %; p<0.001, arterial hypertension 80 % vs. 44 %; p<0.001 and family hCAD 18 % vs. 13 %; p<0.001) and more co-morbidities (chronic kidney disease 26.8 % vs. 4.5 %; p<0.001, history of stroke 11.4 % vs. 3.7 %; p<0.001, peripheral arterial disease 12.9v% vs. 2.3 %; p<0.001, heart failure 12.1 % vs. 1.5 %; p<0.001).

Patients with hCAD were more likely to be referred to the hospital by emergency medical services (238 patients [66 %] vs. 362 patients [49 %];p<0.0001) while patients with no hCAD more frequently were self-referrals (56 patients [15%] vs. 223 patients [30]; p<0.001).

When compared to patients with no hCAD, patients with hCAD were more likely to receive an out of hospital ECG by the emergency doctor prior to admission (31.8 % vs. 20.7 %, p<0.001).

Analysis of time intervals

Pre-Admission

There was statistical difference between the time intervals of initial symptoms to admission to ED in patients with hCAD when compared to patients with no-hCAD (0.8 hours [IQR 0.6 – 11] vs. 12 hours [5 – 18]; p<0.001). Patients with hCAD were more likely to receive a pre-clinical ECG (31.8 % [N115] vs. 20.7 % [N153];p<0.001). (Table 1)

Following admission to ED

The total time in the ED was significantly higher for patients with known CAD when compared with patients with no known CAD (7.5 h [IQR 5 – 10] vs. 6.4h [IQR 5 – 11]; p<0.001). Patients with known CAD had significant shorter time to ECG after admission when compared to patients with no known CAD (20min [IQR 13 – 30] vs. 22 min. [IQR 14 -37]; p<0.001). (Figure 1)

There was a statistically significant difference in door-to-ECG time during different shifts: Night- and early-shift (-4.85 min. [p<0.001; 95 CI -7.39 – -2.32]). (Table 3)

Patients with known CAD were more likely to be admitted during the early shift (48% [N175] vs. 42% [N308]; p=0,04). (Table 2)

Multivariable regression analysis

Multivariable regression analysis of all patient data with the dependent variable being door-to-ECG time showed a relevant association of hCAD on time to ECG with a coefficient of -3 min. (p=0,007; 95% CI -5.16 – -0.84 min.). This association prevailed when only patients admitted via health care professionals (e.g. emergency doctor) were considered with -3.9 min. (n=598; p= 0.006; 95% CI -6.7 – -1.1min.).

Data analysis also showed that patient age correlated with delay in door-to-ECG time (0,007 min. [p=0,012; 95% CI 0,02 – 0.13]). Admission to ED via emergency services was associated with a shorter time to ECG (-3.53 min. [95% CI -5.69 – -1.38 min.; p=0.001]). (Table 3)

If only patients admitted via emergency services were considered (N=598), hCAD was the only factor associated with a shorter door-to-ECG time (-3.93 min. [p=0.006; 95% CI -6.74 – -1.12]). (Table 3b)

Outcome analysis

351 patients were referred to CAG after ED admission, 179 with hCAD and 172 with no hCAD. Male patients with hCAD were more likely to be referred to CAG when compared to patients with no hCAD (70 % [121 N] vs. 52 % [93]; p<0.001) There was no statistically significant difference in number of percutaneous transluminal coronary angioplasty (42 %[76 N] vs.45 % [79];p=0.4) or percutaneous coronary intervention (42 % (76N) vs. 44 %[75] p=0.8) performed in patients with no hCAD and hCAD accordingly. Patients with hCAD were statistically significantly more often discharged with the final diagnose being NSTEMI (45 % [62N] vs. 25 % [36N]. NSTEMI patients with no hCAD had a statistically significant higher levels of creatinkinase within 48 hours after admission (357 U/I [162 – 791] vs. 245 U/I [110 – 385]; p=0.03). There was no statistically significant difference in patients with no hCAD being discharged with the diagnose “Stable Disease” or “Exclusion of relevant CAD” (53 % (91 N) vs. 56 % [101 N]; p=0.5). Patients with hCAD had a statistically significant longer door-to-CAG time (33.3 hours [IQR 9 – 68] vs. 24.5 hours [IQR 5 – 54]; p=0.01) when compared to patients with no hCAD. This statistically significant difference prevailed when looking at patients with final diagnose: NSTEMI (29.5 hours [IQR 10 – 48] vs. 20.7 hours [IQR 6 – 33]; p=0.01). (Table 2).

Discussion

In this single center, retrospective, observational registry, we evaluate the influence of a hCAD on door-to-ECG time in patients referred to the ED for cardiac evaluation and in a subgroup analyses, on patients transferred to CAG on door-to-CAG time when compared to CAD-naïve patients.

We show that hCAD is associated with a decrease in door-to-ECG time especially in patients admitted via emergency services. What’s frequent is common and when presented with an anamnesis of CAD, physicians and nurses seem to suspect a recurrent cardiovascular (CV) event. This strategy is partly supported by several scores showing that patients with a history of CV events are more likely to experience a recurrent CV event especially since they often have an elevated cardiovascular risk profile. It is vital to understand what influences door-to-ECG time after emergency admission to ED as studies show, that door-to-ECG time is one of the main controllable factors influencing door-to-balloon time. (16, 17).

Especially since the new guidelines push for an increased awareness of high-risk NSTEMI patients who are eligible for fast-track coronary angiography, a rapid ECG after ED admission gained a central role in the decision for early reperfusion therapy and a 10 min rule for door-to-ECG time is recommended in

guidelines. (7) Our results show a significantly reduced door-to-ECG time when compared to other studies which may be due to the implementation of a chest pain unit (CPU) into ED management in early 2013. (18) However, still only a fraction received ECG within the suggested time frame especially in self-referral patients. (19) This calls for an increased effort for timely ECG in the ED irrespective of hCAD but may be associated with the fact that a relevant part of included patients received pre-clinical ECGs via the emergency doctor and that in self-referral patients we included the time of triage.

Also associated with door-to-ECG time was patient age with older patients experiencing a delay in door-to-ECG time by the year. Several studies have shown, that older patients are at risk to receiving an assignment of an inappropriately low triage level possibly due to different reference values of vital signs, atypical disease presentations, or the presence of cognitive impairment. (20) Nevertheless rapid diagnostic in ED should be facilitated irrespective of age.

Our data also shows, that in patients with hCAD the referral to subsequent coronary angiography is prolonged despite an increased GRACE score suggesting an early invasive strategy.

This delay in invasive diagnostic might be owed to the fact that patients with hCAD presented with a more complex array of not only cardiovascular risk factors but relevant comorbidities which makes it more difficult for the clinician to get an overview on the patient history and put his current symptoms into perspective. (21) Nonetheless, as those patients presented with a higher TIMI- and GRACE score, they were likely to profit from a more rapid approach. This shows that risk score assessment might be underutilized in ED despite being a useful tool to single out high-risk patients eligible for fast-line diagnostic. (12, 13)

Also, in accordance with other studies, our results show that patients with renal impairment are less likely to receive early CAG. This is most likely of mixed genesis including an uncertainty as to the interpretation of troponin measurements in CKD patients, atypical presentation of symptoms and concerns regarding acute kidney failure after contrast medium induced acute kidney injury. (22–24) Nevertheless, international guidelines also support an early invasive management strategy in CKD patients with suspected AMI due to a 2–5 fold greater risk of death after AMI and ED personnel should be briefed accordingly. (25)

As a result of the aforementioned delayed referral to CAG, it is incidental that patients with hCAD spent longer time at the ED. While the length of stay (LOS) seems to have no impact on quality of care it is a powerful tool to cost savings. (26)

Our data show, that patients with hCAD had increased likelihood for acute myocardial infarction when compared with patients with no hCAD. This is supported by findings in other studies. (27) It may be partly explained by the fact that patients with hCAD had more cardiovascular risk factors and understandable since patients with hCAD had higher probability for recurrent ischemic events determent by TIMI- and GRACE score. (13) Nevertheless hCAD seems to be an easy to gather information for patient triage at ED.

The fact that it already seems to have impact on patient time management in ED all the more qualifies it to be a relevant marker. (12)

We suspected and there are studies elaborating, that patients with hCAD due to the fact that they are able to identify symptoms quicker and arrive at ED faster when compared to CAD naïve patients. (28, 29) Consequently, our data show a statistically significant difference between patients with hCAD and patients with no hCAD in respect to time from beginning of symptoms to admission to ED. Arguably, this might be due to the fact that patients with a hCAD are eligible to recall classical symptoms such as angina pectoris faster and act accordingly.

A similar picture emerges when we examined the modus of referral to the hospital in the different groups with patients with hCAD being far more likely to call and be referred by emergency medical services speaking for an increased awareness in those patients. Consequently those patients were more likely to receive a preclinical ECG, which might improve their outcome as some studies suggest. (16)

Finally, our results show, that door-to-ECG time also depends on the shift during which patients are admitted to the ED. Especially at night with a smaller number of patients admitted door-to-ECG is significantly reduced. Nevertheless, in patients referred via emergency services, hCAD proofed to be the only factor statistically significant associated with shorter door-to-ECG time.

Limitations

The main limitation is the retrospective character of this study. Based on the presented results we plan to initiate an interventional study to improve door-to-ECG time in self-referral patients. Moreover this is a single center observation and we tried to depict all day routine in ED. Consequently we didn´t differentiate between acute coronary syndrome and chest pain. The majority of patients with ST-myocardial infarction are not admitted via ED but directly in the cardiac catheterization laboratory therefore we could not include them. The time frame concerning begin of symptoms was taken from patients memory and is subject to individual deviations. We did include all patients admitted to ED and tried to select via full-text search, however there is still the possibility that patients were admitted for e.g. neurological or orthopaedic diagnostic and developed symptoms in the ED. All patients had hCAD but differ in presentation. That means we also included patients who did undergo elective CAG for example through initiation of a cardiologist. Therefore, such patients wouldn't know the symptoms of ACS. We did not include regression analysis for influence of hCAD on time-to-CAG since there would have been too many confounders.

Conclusion

Our observational data from a single centre registry show, that hCAD prior admission to ED is associated with a shorter door-to-ECG time. Although patients with hCAD were more often high-risk patients with a higher GRACE score, more co-morbidities and a higher cardiovascular risk profile and would therefore

benefit from an early invasive strategy, they are referred to CAG later. Whether this influences patient outcome needs to be evaluated in further clinical trials. In patients presenting in ED for cardiac evaluation, timely ECG diagnostic should be facilitated irrespective of hCAD.

Abbreviations

ED	Emergency Department
ECG	Electrocardiogram
CAD	Coronary Artery Disease
hCAD	History of Coronary artery disease
CAG	Coronary Angiography
AMI	Acute Myocardial Infarction
PAD	Peripheral Artery Disease
FMC	First Medical Contact
LOS	Length Of Stay
CV	Cardiovascular

Declarations

Ethics approval and consent to participate

The protocol of this study conforms to the ethical guidelines of the 1975 Declaration of Helsinki and was henceforth approved by the institutional ethical committee of university of Freiburg (permit numbers EK99/17), which also waived the requirement to obtain any informed consent.

Consent for Publication

Not applicable. As this is a retrospective study informed consent was not obtained from all individual participants included in the study. This procedure is backed by the institutional ethical committee of university of Freiburg (permit numbers EK99/17)

Availability of data and material

The datasets generated for this study are available on reasonable request to the corresponding author.

Competing interests

DD is a member of CRC 1425, funded by the German Research Foundation DFG;

All other authors have no conflicts of interest to declare that are relevant to the content of this article.

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Authors' contributions

LH, IA, and HJB designed the study. LH and TG collected the data. TG, LH, KK, CBO analysed the data. LH, CBO, TG, HJB and IA wrote the manuscript. CB, TW, MH, MR, PMS and PD reviewed and corrected the paper. All authors contributed to the article and approved the submitted version.

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References

1. Christ M, Popp S, Pohlmann H, Poravas M, Umarov D, Bach R, et al. Implementation of high sensitivity cardiac troponin T measurement in the emergency department. Am J Med. 2010;123(12):1134-42.

2. Fruergaard P, Launbjerg J, Hesse B, Jorgensen F, Petri A, Eiken P, et al. The diagnoses of patients admitted with acute chest pain but without myocardial infarction. Eur Heart J. 1996;17(7):1028-34.

3. Coster JE, Turner JK, Bradbury D, Cantrell A. Why Do People Choose Emergency and Urgent Care Services? A Rapid Review Utilizing a Systematic Literature Search and Narrative Synthesis. Acad Emerg Med. 2017;24(9):1137-49.

4. Hampton JR. Five men with chest pain. Practitioner. 1999;243(1596):227-31.

5. Amsterdam EA, Wenger NK, Brindis RG, Casey DE, Jr., Ganiats TG, Holmes DR, Jr., et al. 2014 AHA/ACC Guideline for the Management of Patients with Non-ST-Elevation Acute Coronary Syndromes: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. J Am Coll Cardiol. 2014;64(24):e139-e228.

6. Steg PG, James SK, Gersh BJ. 2012 ESC STEMI guidelines and reperfusion therapy: Evidence-based recommendations, ensuring optimal patient management. Heart. 2013;99(16):1156-7.

7. Ibanez B, James S, Agewall S, Antunes MJ, Bucciarelli-Ducci C, Bueno H, et al. 2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation: The

Task Force for the management of acute myocardial infarction in patients presenting with ST-segment elevation of the European Society of Cardiology (ESC). Eur Heart J. 2018;39(2):119-77.

8. Collet JP, Thiele H, Barbato E, Barthélémy O, Bauersachs J, Bhatt DL, et al. 2020 ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation. Eur Heart J. 2020.

9. Ibanez B, James S, Agewall S, Antunes MJ, Bucciarelli-Ducci C, Bueno H, et al. 2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation: The Task Force for the management of acute myocardial infarction in patients presenting with ST-segment elevation of the European Society of Cardiology (ESC). Eur Heart J. 2018;39(2):119-77.

10. Bhatt DL, Eagle KA, Ohman EM, Hirsch AT, Goto S, Mahoney EM, et al. Comparative determinants of 4-year cardiovascular event rates in stable outpatients at risk of or with atherothrombosis. Jama. 2010;304(12):1350-7.

11. Knuuti J, Wijns W, Saraste A, Capodanno D, Barbato E, Funck-Brentano C, et al. 2019 ESC Guidelines for the diagnosis and management of chronic coronary syndromes. Eur Heart J. 2020;41(3):407-77.

12. Laureano-Phillips J, Robinson RD, Aryal S, Blair S, Wilson D, Boyd K, et al. HEART Score Risk Stratification of Low-Risk Chest Pain Patients in the Emergency Department: A Systematic Review and Meta-Analysis. Ann Emerg Med. 2019;74(2):187-203.

13. D'Ascenzo F, Biondi-Zoccai G, Moretti C, Bollati M, Omede P, Sciuto F, et al. TIMI, GRACE and alternative risk scores in Acute Coronary Syndromes: a meta-analysis of 40 derivation studies on 216,552 patients and of 42 validation studies on 31,625 patients. Contemp Clin Trials. 2012;33(3):507-14.

14. Januzzi JL, Jr., McCarthy CP. Evaluating Chest Pain in the Emergency Department: Searching for the Optimal Gatekeeper. J Am Coll Cardiol. 2018;71(6):617-9.

15. Valadkhani S, Jalili M, Hesari E, Mirfazaelian H. Validation of the North American Chest Pain Rule in Prediction of Very Low-Risk Chest Pain; a Diagnostic Accuracy Study. Emerg (Tehran). 2017;5(1):e11.

16. Brown JP, Mahmud E, Dunford JV, Ben-Yehuda O. Effect of prehospital 12-lead electrocardiogram on activation of the cardiac catheterization laboratory and door-to-balloon time in ST-segment elevation acute myocardial infarction. Am J Cardiol. 2008;101(2):158-61.

17. Sekulic M, Hassunizadeh B, McGraw S, David S. Feasibility of early emergency room notification to improve door-to-balloon times for patients with acute ST segment elevation myocardial infarction. Catheter Cardiovasc Interv. 2005;66(3):316-9.

18. Goodacre S, Nicholl J, Dixon S, Cross E, Angelini K, Arnold J, et al. Randomised controlled trial and economic evaluation of a chest pain observation unit compared with routine care. BMJ. 2004;328(7434):254.

19. Coyne CJ, Testa N, Desai S, Lagrone J, Chang R, Zheng L, et al. Improving door-to-balloon time by decreasing door-to-ECG time for walk-in STEMI patients. West J Emerg Med. 2015;16(1):184-9.

20. Blomaard LC, Speksnijder C, Lucke JA, de Gelder J, Anten S, Schuit SCE, et al. Geriatric Screening, Triage Urgency, and 30-Day Mortality in Older Emergency Department Patients. Journal of the American Geriatrics Society. 2020;68(8):1755-62.

21. Khafaji HA, Suwaidi JM. Atypical presentation of acute and chronic coronary artery disease in diabetics. World J Cardiol. 2014;6(8):802-13.

22. Shaw C, Nitsch D, Steenkamp R, Junghans C, Shah S, O'Donoghue D, et al. Inpatient coronary angiography and revascularisation following non-ST-elevation acute coronary syndrome in patients with renal impairment: a cohort study using the Myocardial Ischaemia National Audit Project. PLoS One. 2014;9(6):e99925.

23. Lamb EJ, Hall EM, Fahie-Wilson M. Cardiac troponins and chronic kidney disease. Kidney Int. 2006;70(8):1525-6; author reply 6.

24. Wickenbrock I, Perings C, Maagh P, Quack I, van Bracht M, Prull MW, et al. Contrast medium induced nephropathy in patients undergoing percutaneous coronary intervention for acute coronary syndrome: differences in STEMI and NSTEMI. Clin Res Cardiol. 2009;98(12):765-72.

25. Go AS, Chertow GM, Fan D, McCulloch CE, Hsu CY. Chronic kidney disease and the risks of death, cardiovascular events, and hospitalization. N Engl J Med. 2004;351(13):1296-305.

26. Vermeulen MJ, Guttmann A, Stukel TA, Kachra A, Sivilotti ML, Rowe BH, et al. Are reductions in emergency department length of stay associated with improvements in quality of care? A difference-in-differences analysis. BMJ Qual Saf. 2016;25(7):489-98.

27. Dezman ZD, Mattu A, Body R. Utility of the History and Physical Examination in the Detection of Acute Coronary Syndromes in Emergency Department Patients. West J Emerg Med. 2017;18(4):752-60.

28. Bastos AS, Beccaria LM, Contrin LM, Cesarino CB. Time of arrival of patients with acute myocardial infarction to the emergency department. Rev Bras Cir Cardiovasc. 2012;27(3):411-8.

29. Sheifer SE, Rathore SS, Gersh BJ, Weinfurt KP, Oetgen WJ, Breall JA, et al. Time to presentation with acute myocardial infarction in the elderly: associations with race, sex, and socioeconomic characteristics. Circulation. 2000;102(14):1651-6.

Tables

Due to technical limitations, table 1-3 is only available as a download in the Supplemental Files section.

Figures

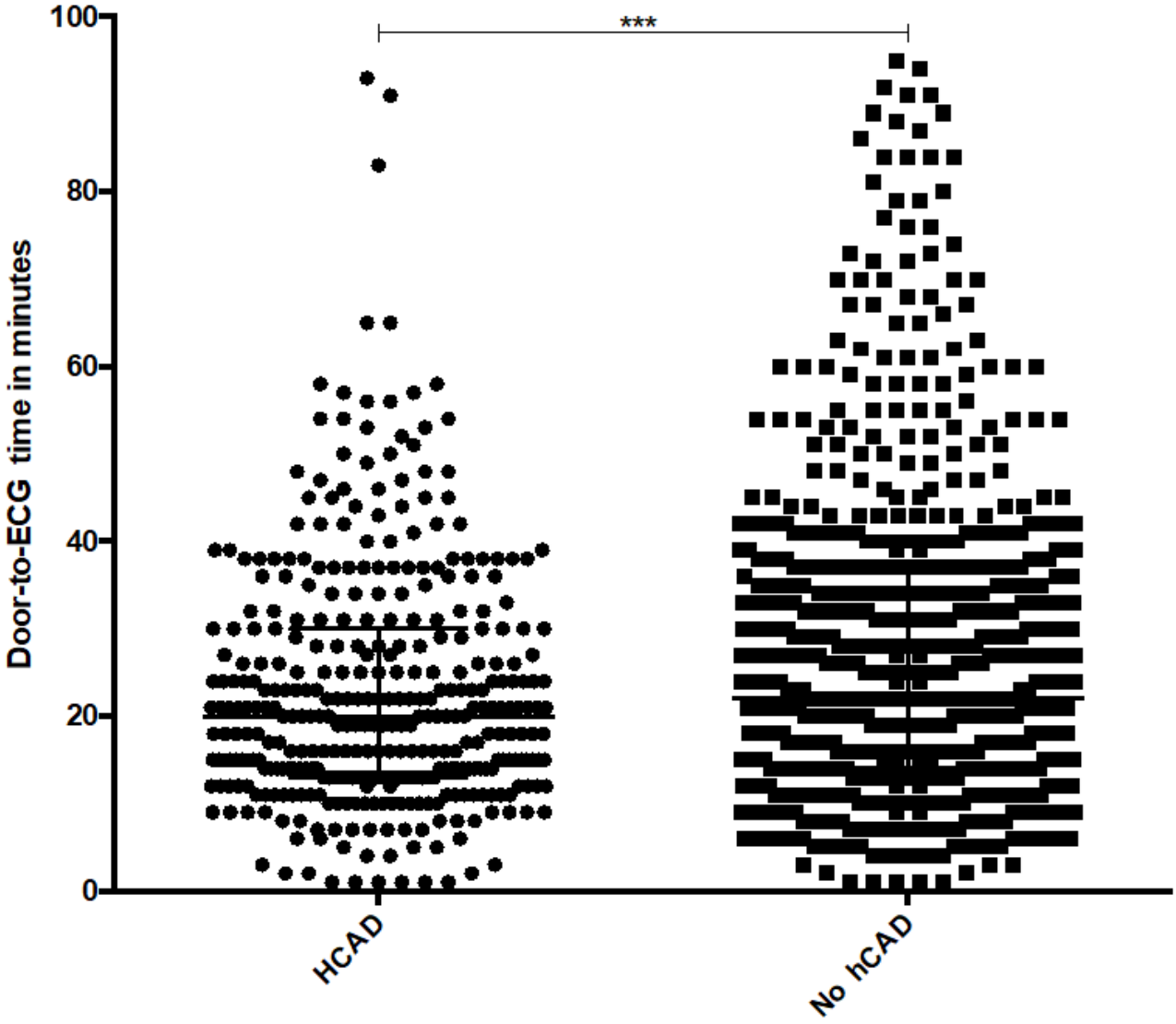

Figure 1

Time to ECG in patients with hCAD and no hCAD respectively. Data are presented as Scatter blocks with median and interquartile range. *** p<0,001; CAD= Coronary artery disease

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Tables.pdf