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Few with ST-segment elevation myocardial infarction are diagnosed within 10 minutes from first medical contact, and women have longer delay times than men

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ABSTRACT

Background: Previous reports have questioned the feasibility and gender equality of obtaining a prehospital ECG within 10 minutes of ambulance arrival for patients with ST-segment elevation myocardial infarction (STEMI). The main objective of this study was to investigate the proportion of STEMI patients with a prehospital ECG within 10 minutes of ambulance arrival. The secondary objective was to study the gender differences in delay times in prehospital STEMI care.

Methods: This study was a retrospective study based on 539 patients with STEMI at the investigating hospital. Ambulance and medical charts, as well as the national quality registry "SWEDEHEART", were reviewed for each patient for demographics and time information.

Results: A prehospital ECG was obtained within 10 minutes of ambulance arrival for 99 (29%) of the men and 19 (14%) of the women, p = 0.001. Women had a 2 minutes longer delay between ambulance arrival and prehospital ECG (95% CI 0–4 min, p = 0.018) than men. Women also had a significantly longer patient delay. None of the other time intervals differed among men and women.

Conclusions: Only for a minority of patients is a prehospital ECG taken within the recommended ten minutes from ambulance arrival. Women have longer patient delay times, as well as delay times to the acquisition of a prehospital ECG than men. Improvements of prehospital ECG acquisition and adjustments of the guidelines are warranted.

1. Introduction

Shorter delay to reperfusion therapy is associated with better outcomes and lower mortality in patients with ST-segment myocardial infarction (STEMI) [1,2]. To minimize delay to reperfusion therapy, current international guidelines recommend organization of networks between hospitals and ambulance service [3]. For STEMI patients arriving by ambulance to a percutaneous coronary intervention (PCI) capable hospital, it is recommended that a 12-lead ECG recording and interpretation is made within 10 minutes of ambulance arrival as well as wire crossing within 90 minutes of STEMI diagnosis [3]. A previous report has however questioned the feasibility and gender equality of obtaining a prehospital ECG within 10 minutes of ambulance arrival. In a small single-center study, only 16% of patients arriving to the catheterization laboratory had a prehospital ECG obtained within 10 minutes, and women had a seven minute longer delay from first medical contact (FMC) to ECG compared to men [4]. Other reports have raised awareness that female gender is associated with longer prehospital delay times [5–7]. Mainly, the time from symptom onset to contact with the health care system has been found to be significantly longer for women [5]. Only few studies have investigated the gender differences of the time components that constitute the system delay [7,8].

The primary objective of this study was to study the feasibility of acquiring a prehospital ECG within 10 minutes from FMC. The secondary objectives were to confirm the gender differences in delay times from FMC to prehospital ECG and to study if gender is associated with differences in delay in the various aspects of time components involved in STEMI care.

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2. Methods

We conducted a retrospective cohort study among all STEMI patients arriving to Danderyd Hospital between 17 December, 2010, and 27 July, 2015. The investigating hospital is university hospital located in an urban setting in Stockholm, Sweden, with a catchment area of around 500,000 inhabitants. All patients were identified using the national quality registry "Swedish Web-system for Enhancement and Development of Evidence-based care in Heart disease Evaluated According to Recommended Therapies", SWEDEHEART. The quality registry collects data prospectively from all Swedish hospitals treating patients with acute coronary syndrome, and the registry data are continuously monitored, both internally and externally, for validity. All patients who had the final diagnosis of STEMI entered in SWEDEHEART, and who had been treated at the investigating hospital during the study period, were included. Patients who did not arrive by ambulance, or for whom a prehospital ECG had not been transmitted, as well as patients who did not undergo coronary angiography or if coronary angiography was delayed for more than six hours, were excluded. Background characteristics were extracted directly from the registry. For information on time delay components, the times of emergency call, ambulance arrival, and drop off time at the hospital were acquired manually from the ambulance reports found in the electronic medical charts. The time of the prehospital ECG was obtained from a local database storing all prehospital ECGs sent to the hospital (Mobimed, Ortivus, Danderyd, Sweden). The time of arterial puncture was obtained from SWEDEHEART.

We defined *patient delay* as time from symptom onset to the time when the patient contacted emergency services, *response time* as the time from the emergency call to ambulance arrival, *ECG time* as the time from ambulance arrival to transmission of the prehospital ECG, *transport time* as the time from transmission of the prehospital ECG to arrival at the hospital, and *hospital time* as the time from arrival at the hospital to the time of arterial puncture.

All continuous variables were reviewed by histogram and the Shapiro Wilks' test was applied for normality. For time intervals, the median and interquartile ranges were defined, and compared using the Wilcoxon Rank Sum test. For the univariate and multiple variate regression models, quantile regression with 1000 bootstrap repetitions was used. Dichotomous variables were described as absolute numbers and percentages, and compared with either the Chi^2 test or Fischer's exact test. All statistical analyses were performed using Stata/SE 14.2 (StataCorp LLC, Texas, USA). The study was in accordance to the Declaration of Helsinki and a waiver of consent was obtained from the regional ethics committee (Dnr 2014/294-31).

3. Results

3.1. Study cohort

In total, 916 STEMI patients were identified during the study period. After excluding patients who did not arrive by ambulance (n = 184) and patients for whom no prehospital ECG was transmitted (n = 109), 623 patients remained. We further excluded 67 patients who did not do angiography and 17 who had a delay time from ECG to arterial puncture more than six hours. The remaining 539 patients constituted the main study cohort (Fig. 1).

3.2. Baseline characteristics

One hundred fifty-four (29%) subjects were women and 385 patients were men. With a median age of 74, women were significantly older than men (p < 0.001, Table 1). Women were also more often smokers, had a previously known systolic heart failure and hypertension.

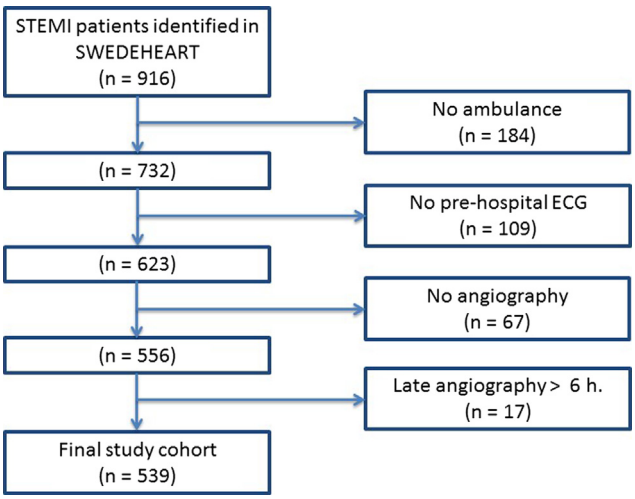

Fig. 1. Flow chart of patient participation and exclusion. ECG = Electrocardiogram. STEMI = ST-segment Elevation Myocardial Infarction. SWEDEHEART = Swedish Web-System for Enhancement and Development of Evidence-Based Care in Heart Disease Evaluated According to Recommended Therapies.

3.3. Time targets

The time target of the acquisition of a prehospital ECG within 10 minutes of ambulance arrival was met for 99 (29%) of the men and 19 (14%) of the women (p = 0.001), Table 2. Almost 90% of all patients met the time target of prehospital ECG to arterial puncture within 90 min, and there was no difference according to gender regarding this.

3.4. Gender differences in time intervals

Patient delay was significantly longer for women than for men, median 61 vs 45 minutes (p = 0.031) and women had longer ECG time; 17 minutes for women and 14 minutes for men (p < 0.001; Table 2). There were no other differences between the genders in the other time delay components studied. Also, there were no gender differences in total time delay (Table 2).

The unadjusted difference in ECG time between men and women was 3 minutes (95% CI 1–5), p < 0.001. When adjusting only for age, the difference was unchanged; 3 minutes (95% CI 0–5 min), p = 0.020. Adjusting for age, smoking, low-EF and hypertension by multiple regression there was a gender difference of 2 minutes (95% CI 0–4 min), p = 0.018.

4. Discussion

The target of STEMI diagnosis within 10 minutes of ambulance arrival, set forth by the European Society of Cardiology [9], relies on the acquisition of a prehospital ECG within that time. In this study, this target was only met for 29% of the men and for 14% of the women. In a Brazilian cohort, time to ECG within 10 minutes was achieved for 33% [8]. The guideline-proposed target is based in large on data from the "Can Rapid Risk Stratification of Unstable Angina Patients Suppress Adverse Outcomes with Early Implementation of the American College of Cardiology/American Heart Association Guidelines" (CRUSADE) Initiative [10]. The CRUSADE database includes information on patients who present in the emergency department, which is a different setting than in a

Table 1
Baseline characteristics and gender differences in baseline characteristics. All values expressed as n (%) unless otherwise stated.

	Total (n = 539)	Men (n = 385)	Women (n = 154)	p
Swedish nationality	534 (99)	381 (99)	153 (99)	1.000
Age, years, median [IQR]	67 [59, 76]	65 [57, 74]	74 [65, 81]	<0.001
BMI, kg/m^2, median [IQR]	26 [24, 29]	24 [20, 31]	25 [22, 30]	0.092
Current Smoking	136 (25)	87 (23)	49 (32)	0.022
Previous AMI,	87 (16)	63 (16)	24 (16)	0.829
Previous PCI	66 (12)	50 (13)	16 (10)	0.395
Reduced EF	21 (4)	10 (3)	11 (7)	0.015
Diabetes mellitus	104 (19)	72 (19)	32 (21)	0.581
Hypertension	263 (49)	169 (44)	94 (61)	<0.001
Previous stroke	31 (6)	23 (6)	8 (5)	0.733
Systolic blood pressure, mm Hg, median [IQR]	135 [118, 150]	135 [114, 170]	135 [117, 160]	1.000
Diastolic blood pressure, mm Hg, median [IQR]	80 [70, 90]	80 [62, 90]	80 [66, 90]	1.000
On-call hours*	335 (62)	240 (62)	95 (62)	0.495

*On-call hour defined as weekdays 4 pm–8 am, weekends, and national holidays.
AMI = Acute Myocardial Infarction.
BMI = Body Mass Index.
EF = Ejection Fraction.
IQR = Inter-Quartile Range.
PCI = Percutaneous Coronary Intervention.

Table 2
Time delay components of the prehospital chain of care by gender.

Time intervals	Men (n = 385) Minutes, median [IQR]	Women (n = 184) Minutes, median [IQR]	p
Patient delay[a]	45 [15, 115]	61 [29, 156]	0.031
Response time[b]	14 [10, 19]	13 [10, 17]	0.084
ECG time[c]	14 [9, 19]	17 [13, 22]	<0.001
Transport time[d]	23 [17, 30]	22 [16, 27]	0.337
Hospital time[e]	27 [16, 48]	28 [18, 40]	0.821
Emergency call to arterial puncture	80 [67, 102]	82 [67, 95]	0.688
Ambulance arrival to arterial puncture	63 [52, 84]	66 [55, 81]	0.350
Prehospital ECG to arterial puncture	49 [38, 68]	47 [36, 64]	0.288
Time targets	**n (%)**	**n (%)**	
Ambulance arrival to prehospital ECG within 10 min	99 (29)	19 (14)	0.001
Ambulance arrival to arterial puncture within 90 min	282 (81)	114 (82)	0.577
Prehospital ECG to arterial puncture within 90 min	337 (88)	137 (89)	0.697

ECG = Electrocardiogram.
IQR = Interquartile range.
[a] Time from symptom onset to emergency call.
[b] Time from emergency call to ambulance arrival.
[c] Time from ambulance arrival to prehospital ECG.
[d] Time from prehospital ECG to arrival to the hospital.
[e] Time from hospital arrival to arterial puncture in the catheterization laboratory.

prehospital environment. Ambulance arrival at the patient's address is normally logged when the ambulance is parked, thus requiring some time for EMS staff to enter and locate the patient. Even so, in the CRUSADE cohort an ECG was acquired within 10 minutes for only 34.8% of all patients, and the authors also found that female gender was associated with such acquisition taking longer time than 10 minutes (adjusted odds ratio 1.29, 95% CI 1.25–1.34). In all, there seems to be little evidenced based support that a prehospital ECG within 10 minutes of ambulance arrival is a feasible target.

In this study, we found that the delay time from ambulance of arrival to the acquisition of a prehospital ECG is indeed longer for women than for men. This finding is in accordance to our previous report [4] but contrary to the findings of another recently published study from Sweden, where the time from medical contact to diagnostic ECG did not differ according to gender [5]. In that report the difference in average time was 8 minutes, and the p-value borderline significant (p = 0.09). The authors of that study used a slightly different definition of "first medical contact" and initiated the system delay time as the time at which the patient contacted EMS. This could account for the difference in comparison to the present study. The finding of a 3 minute longer ECG time for women remained also after adjusting for age. Increasing age has also been shown to be associated with longer prehospital delay times, which was the rationale for adjusting for this variable [6]. The difference in ECG time between the genders also persisted after adjusting for other covariates that differed in the baseline characteristics. The reason for this difference is not clear. A possible reason could be that women often present with atypical symptoms that could be misinterpreted by patient and EMS staff alike. Also, it could be slightly more uncomfortable for a woman to remove the clothing from the upper body. Many STEMI alert activations start at the time of ECG; a long delay time to prehospital ECG may thus aggravate the prognosis for the patient.

Although we report a difference in ECG time between men and women, we did not find a difference in total time from ambulance arrival to arterial puncture. This finding is congruent with previous reports from Stockholm, Sweden [4] and Salvador, Brazil [8] but other centers have reported differences in total delay times [5–7]. Aguilar et al studied gender differences in prehospital time components for STEMI patients before and after the implementation of prehospital ECGs and found a mean difference of 4 minutes between the genders [7]. In that study, the scene time was also significantly longer for women. It could be argued, that since women have a longer patient delay, an even shorter system delay is motivated for women than for men. Even after adjusting for age and other co-morbidities, women seem to have a higher rate of in-hospital mortality [11] and excess mortality compared with men [12]. In the in-hospital setting, door-to-ECG time in the emergency department setting has similarly been found to be longer for women than for men [13]. The current study was underpowered to detect a difference in prognosis with regards to the time components, and thus such analyses were not performed.

In accordance to numerous previous reports, patient delay was significantly longer for women than for men [5,14–16]. Plausible reasons for this could be due to the fact that women more often present with atypical symptoms and longer time to decision [5].

5. Limitations

This study was conducted at a single center institution, which could affect generalizability. The investigating hospital is however among the largest centers in Sweden, treating some 250 STEMI patients each year, increasing the sample size and internal validity of the study.

6. Conclusion

In conclusion, only a minority of patients have an ECG taken within the recommended ten minutes from FMC. Women have longer patient delay time and FMC to ECG delay time than men. Both improvements of prehospital ECG acquisition and adjustments of the guidelines are warranted.

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The authors have nothing to declare.

Declaration of Competing Interest

The authors have no conflicts of interest to declare.

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Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijcha.2019.100458.

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