Clinical paper

Gender differences in utilization of coronary angiography and angiographic findings after out-of-hospital cardiac arrest: A registry study

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Abstract

Introduction: We investigated the impact of gender in performance and findings of early coronary angiography (CAG) and percutaneous coronary intervention (PCI), comorbidity and outcome in a large population of out-of-hospital cardiac arrest (OHCA) patients with an initially shockable rhythm.
Methods: Retrospective cohort study. Data retrieved 2008–2013 from the Swedish Register for Cardio-Pulmonary Resuscitation, Swedeheart Registry and National Patient Register.
Results: We identified 1498 patients of whom 78% were men. Men and women had the same pathology on the first registered electrocardiogram (ECG): 30% vs. 29% had ST-elevation and 10% vs. 9% had left bundle branch block (LBBB) ($P = 0.97$). Proportions of performed CAG did not differ between genders. Among patients without ST-elevation/LBBB men more often had at least one significant stenosis, 78% vs. 54% ($P = 0.001$), more multi-vessel disease ($P = 0.01$), had normal coronary angiography less often, 22% vs. 46% and PCI more often, 59% vs. 42% ($P = 0.03$). Among patients without ST-elevation/LBBB on the initial ECG, more men had previously known ischaemic heart disease, 27% vs. 19% ($P = 0.02$) and a presumed cardiac origin of the cardiac arrest, 86% vs. 72% ($P < 0.001$). Multivariable analysis showed no association between gender and evaluation by early CAG. In men and women, 1-year survival was 56% vs. 50% ($P = 0.22$) in patients with ST-elevation/LBBB and 48% vs. 51% ($P = 0.50$) in patients without.
Conclusion: Despite no gender differences in ECG findings indicating an early CAG, men had more severe coronary artery disease while women more frequently had normal coronary angiography. However, this did not influence 1-year survival.
Keywords: Cardiac arrest, Gender differences, Out-of-hospital cardiac arrest, Coronary angiography, Percutaneous coronary intervention, Ventricular fibrillation, CPR, Registry study

Introduction

In Sweden, like the rest of Europe, resuscitation after out-of-hospital cardiac arrest (OHCA) is attempted in around 50/100,000 persons/year.[1,2] The focus on post-resuscitation care, including coronary angiography (CAG) and percutaneous coronary intervention (PCI) may have contributed to the increased survival after OHCA seen in recent decades. Up to 96% of patients referred for CAG with ST-elevation on ECG after return of spontaneous circulation (ROSC) have at least one significant coronary lesion.[3,4]

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Several registry and observational studies have shown that CAG may improve outcome after OHCA.[5–7] The European Resuscitation Council and European Society of Intensive Care Medicine Guidelines for Post-Resuscitation Care 2015[8] stress the need for early revascularization, recommending CAG to be considered in all successfully resuscitated OHCA victims with no obvious non-cardiac cause of the arrest, even without an ECG indicating ischaemia. However, with few exceptions,[4,9] data in support of early CAG are observational and from selected populations, with patients who have already been referred to the catheterization laboratory.

Female gender is independently associated with lower use of early CAG.[10–12] Among several characteristics important for survival, women suffering from OHCA have a suspected cardiac origin of the arrest less often[13–16] and similar to after acute coronary syndrome (ACS) they undergo CAG and PCI more seldom.[10,13,17–21] However, in studies controlling for confounders, men and women suffering from OHCA have similar rates of CAG leading to PCI.[10,11,18] Women have lower rates of a shockable first ECG rhythm (VF/VT), which may be viewed as an indicator of cardiac aetiology. Among patients with a shockable first rhythm, female gender is even associated with good long-term outcome[16] which is not seen in studies of OHCA victims irrespective of first rhythm.[14,22,23]

It is important to identify which patients to refer for early CAG after OHCA, i.e. to find those who will probably benefit from treatment with PCI but also to identify those who will not benefit. We can thereby avoid unnecessary risks and minimize delays of temperature management and cardiovascular and respiratory optimization. Furthermore, today's guidelines do not exclude patients without ST-elevation from early CAG, but evidence for immediate CAG are weaker in this group even if 58% of these patients have at least one significant coronary artery lesion.[4]

This is a large population of consecutively enrolled OHCA patients who had an initially shockable rhythm with an expected high proportion of cardiac origin of the arrest. After stratifying by first registered ECG after ROSC, we aimed to investigate the interaction of gender and utilization of early CAG and PCI, CAG findings, comorbidity and outcome.

Material and methods

The population

This is a national descriptive study based on prospectively entered data from three different Swedish health care registers. All patients 18 years or older, with an initially shockable ECG rhythm admitted alive and comatose after OHCA and registered in the Swedish Register for Cardio-pulmonary Resuscitation (SRCR)[1] from 2008 to 2013 were identified (see Fig. 1). Data were merged with the Swedeheart Registry[24] to identify patients treated with early CAG after the OHCA. Patients undergoing CAG on the same day as the OHCA were deemed to have early CAG. CAG findings and procedures, as well as ECG findings after ROSC, were retrieved from the same registry. Missing registry data on ECG findings were completed from patients' electronic health records. ECGs were evaluated based on the 2017 European Society of Cardiology guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation.[25] Comorbidity data, based on ICD codes of hospitalizations prior to the cardiac arrest, were collected from the National Patient Register
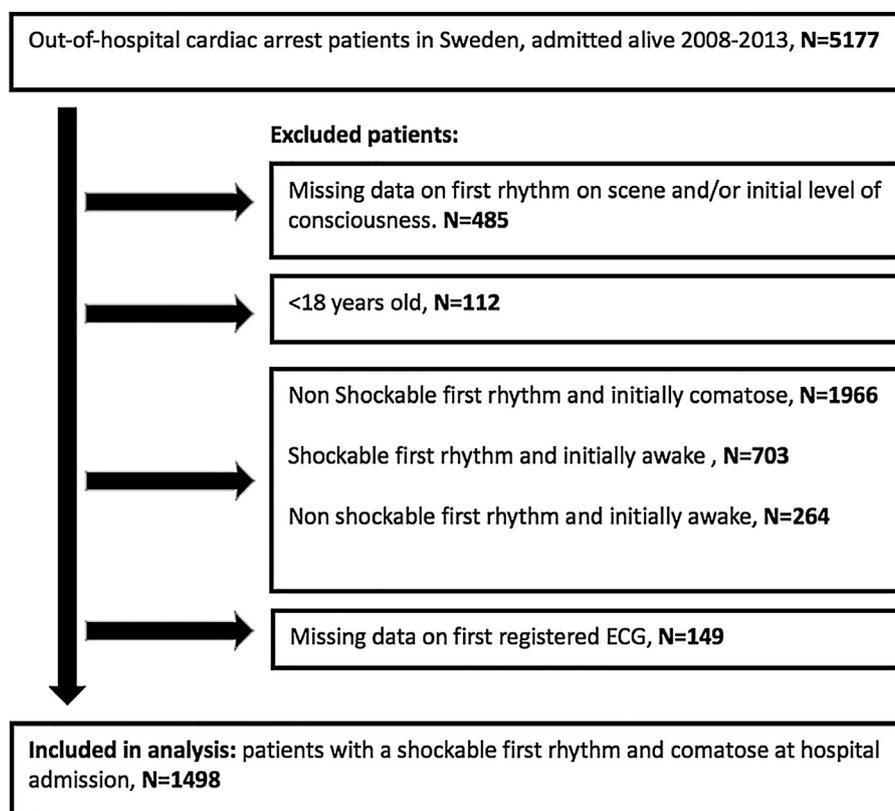

Fig. 1 – Participant flow.

(NPR). The presumed aetiology of the arrest was based on the paramedics' judgement and retrieved from the Swedeheart Registry.

Data sources

All Emergency Medical Service organizations reports data on mainly prehospital factors and survival to the SRCR registry,[1] covering almost all cases of OHCA in Sweden.

The Swedeheart register system[24] (The Swedish Web-system for Enhancement and Development of Evidence-based care in Heart disease Evaluated According to Recommended Therapies) is a web-based registry system where all patient data are registered online by the caregiver. Patients are informed about inclusion into the registry and given the opportunity to decline participation. The registry collects data on CAG and PCI from all patients investigated and treated at all centres performing coronary interventions, as well as data about demographics, risk factors, comorbidity, treatment, complications and outcome from all patients treated at coronary care units. The NPR registry contains ICD codes from all hospital admissions and mortality data on Swedish inhabitants, who are identified by each person's unique personal identification number. After obtaining data from the Swedish National Board of Health and Welfare, data were anonymized according to regulations.

Ethical approval

The study was approved by the regional ethics review board in Stockholm, Sweden (Reg. no. 2014/1139-31/2). It was conducted in accordance with regulatory requirements, and the ethical principles of the Declaration of Helsinki.

Statistics

Dichotomous variables were tested with the chi-square test. Continuous variables were compared across groups using the Mann–Whitney U-test. Logistic regression was performed, examining the impact of gender on utilization of early CAG while controlling for confounding variables. In this analysis all ST-elevations and left bundle branch blocks (LBBBs) were analyzed together in one group while patients with other ECG patterns were analyzed in the other group. A P-value <0.05 was considered significant. In our multivariable analysis complete cases were analyzed. 5.9% of cases in the ST-elevation/LBBB group and 6.5% in the group without ST-elevation/LBBB had missing data, as shown in detail in Table 1. As a sensitivity analysis accounting for missing data, multiple imputation was performed under the assumption that data were missing at random. Multiple imputation was performed

Table 1 – Baseline data[a]. Data are presented as No. (%) of participants unless otherwise indicated.

	Total population ($n=1498$)			ST-elevation or LBBB ($n=593$)			No ST-elevation or LBBB ($n=905$)		
	Men ($n=1171$) (78%)	Women ($n=327$) (22%)	P-value	Men ($n=466$) (79%)	Women ($n=127$) (21%)	P-value	Men ($n=705$) (78%)	Women ($n=200$) (22%)	P-value
Age, years, mean (range)	66.2 (18–96)	65.3 (18–96)	0.68	65.0 (18–96)	67.2 (25–95)	0.06	67.0 (18–94)	64.1 (18–96)	0.07
Comorbidity									
Hypertension	281 (24)	86 (26)	0.39	97 (21)	27 (21)	0.91	184 (26)	59 (30)	0.34
Diabetes (type 1 or 2)	143 (12)	37 (11)	0.66	43 (9)	8 (6)	0.30	100 (14)	29 (15)	0.91
Ischaemic heart disease	257 (22)	53 (16)	0.02	93 (20)	22 (17)	0.51	190 (27)	38 (19)	0.02
COPD	45 (4)	17 (5)	0.28	12 (3)	5 (4)	0.42	33 (5)	12 (6)	0.45
Previous MI	101 (9)	23 (7)	0.36	36 (8)	10 (8)	0.96	65 (9)	13 (7)	0.23
Previous PCI	55 (5)	10 (3)	0.20	24 (5)	4 (3)	0.35	31 (4)	6 (3)	0.38
Atrial fibrillation	185 (16)	44 (14)	0.30	47 (10)	8 (6)	0.19	138 (20)	36 (18)	0.62
Heart failure	202 (17)	54 (17)	0.75	59 (13)	12 (9)	0.32	143 (20)	42 (21)	0.83
Kidney failure	42 (4)	10 (3)	0.64	13 (3)	2 (2)	0.44	29 (4)	8 (4)	0.94
Stroke	67 (6)	25 (8)	0.20	17 (4)	7 (6)	0.35	50 (7)	18 (9)	0.37
Cancer	130 (11)	31 (10)	0.40	40 (9)	7 (6)	0.26	90 (13)	24 (12)	0.77
Circumstances of the OHCA									
Witnessed OHCA[b]	1077 (93) ($n=1155$)	287 (91) ($n=317$)	0.10	427 (93) ($n=460$)	110 (89) ($n=123$)	0.22	650 (94) ($n=695$)	177 (91) ($n=194$)	0.27
Crew-witnessed OHCA[b]	118 (10)	44 (14)	0.07	69 (15)	15 (12)	0.43	49 (7) $n=695$	29 (15) $n=194$	0.001
Bystander CPR[c]	803 (69) ($n=1159$)	215 (67) ($n=321$)	0.43	314 (68) ($n=460$)	78 (61) ($n=127$)	0.15	489 (70) ($n=699$)	137 (71) ($n=194$)	0.86
Suspected cardiac origin of the OHCA[d]	983 (88) ($n=1113$)	243 (78) ($n=313$)	<0.001	412 (92) ($n=450$)	107 (87) ($n=123$)	0.13	571 (86) ($n=663$)	136 (72) ($n=190$)	<0.001
OHCA at home	576 (49)	204 (62)	<0.001	237 (51)	92 (72)	<0.001	339 (48)	112 (56)	0.048
EMS response time, min, mean (range)[e]	7 (0–73) ($n=1133$)	9 (0–78) ($n=310$)	<0.001	8 (0–73) ($n=451$)	9 (0–78) ($n=123$)	0.06	7 (0–34) ($n=682$)	8 (0–27) ($n=187$)	<0.001

Abbreviations: COPD, chronic obstructive pulmonary disease; MI, myocardial infarction; PCI, percutaneous coronary intervention; OHCA, out-of-hospital cardiac arrest; CPR, cardiopulmonary resuscitation; EMS, emergency medical services.

[a] Statistics are calculated on all patients ($n=1498$) unless otherwise indicated.

[b] Missing data in men and women: 1.3% and 3.1% (ST-elevation/LBBB); 1.4% and 3.0% (no ST-elevation/LBBB).

[c] Missing data in men and women: 1.3% of the men (ST-elevation/LBBB); 0.8% and 3.0% (no ST-elevation/LBBB).

[d] Missing data in men and women: 3.4% and 3.1% (ST-elevation/LBBB); 6.0% and 5.0% (no ST-elevation/LBBB).

[e] Missing data in men and women: 3.2% and 3.1% (ST-elevation/LBBB); 3.3% and 6.5% (no ST-elevation/LBBB).

using all variables in our primary analysis model. Only minor dissimilarities regarding odds ratio estimates were seen after multiple imputation why we present the former.

Early CAG was defined as CAG performed during the same day as the OHCA. In the group receiving no early CAG, patients receiving no CAG at all and those receiving CAG after that first day but no later than after 4 weeks were grouped together. Statistical analyses were performed using IBM SPSS Statistics for Mac OS, Version 23.0, Armonk, NY: IBM Corp.

Results

Background data

In our final analysis, outlined in Fig. 1, we included 1498 patients, successfully resuscitated after OHCA, with an initially shockable rhythm and comatose at hospital admission. Forty percent (593 patients) had ST-elevation or LBBB, (79% men), and 60% (905 patients) had other ECG findings (78% men) (Table 1). In both men and women, 18% had a normal ECG. Among patients without ST-elevation/LBBB more men had previously known ischaemic heart disease, 27% vs. 19% ($P = 0.02$) and a presumed cardiac origin of the cardiac arrest, 86% vs. 72% ($P < 0.001$), but shorter EMS response time, median 6 vs. 7 min ($P < 0.001$) and lower incidence of crew-witnessed OHCA, 7% vs. 15% ($P = 0.001$). Regardless of the first registered ECG, more women had OHCA at home.

ECG after ROSC, CAG findings and treatment

Men and women did not differ in respect to their first registered ECG findings ($P = 0.97$): 30% vs. 29% had ST-elevation, 10% vs. 9% had LBBB, respectively, and 18% of both men and women had a normal ECG. There was no gender difference in proportions of CAG in any of the groups. In the group with no ST-elevation/LBBB more men had PCI following CAG, 59% vs. 42% ($P = 0.03$) and more often at least one significant stenosis, 78% vs. 54% ($P = 0.001$). In the same group CAG findings differed between genders ($P = 0.01$) with men having more 3-, 2- and 1-vessel disease (see Table 2), and normal coronary angiography less frequently, 22% vs. 46%.

Multivariable analysis

To investigate the impact of gender on early CAG utilization while controlling for confounding variables, gender, age, comorbidity, and circumstances of the OHCA was entered in the model. Regardless of first registered ECG we found no association between female gender and the use of early CAG, odds ratio (OR) 0.85, 95% confidence interval (CI) 0.53–1.36, $P = 0.49$ (patients with ST-elevation/LBBB) and OR 0.74, 95% CI 0.50–1.10, $P = 0.14$ (patients without ST-elevation/LBBB). The logistic regression model showed similar odds ratio estimates in the two groups after multiple imputation, OR 0.85, 95% CI 0.54–1.34, $P = 0.48$ and OR 0.71, 95% CI 0.49–1.02, $P = 0.07$, respectively.

Crew-witnessed OHCA in the ST-elevation/LBBB group was associated with the use of early CAG. Increasing age, previously

Table 2 – ECG after ROSC, CAG findings and treatment[a]. Data are presented as No. (%) of participants.

	Total population (n = 1498)			ST-elevation or LBBB (n = 593)			No ST-elevation or LBBB (n = 905)		
	Men (n = 1171)	Women (n = 327)	P-value	Men (n = 466)	Women (n = 127)	P-value	Men (n = 705)	Women (n = 200)	P-value
First registered ECG			0.97			0.95			0.82
ST-elevation	346 (30)	96 (29)		346 (74)	96 (76)				
LBBB	116 (10)	30 (9)		116 (25)	30 (24)				
RBBB + ST-elevation	4 (0.3)	1 (0.3)		4 (0.9)	1 (0.8)				
Normal ECG	214 (18)	60 (18)					214 (30)	60 (30)	
ST-depression	163 (14)	51 (16)					163 (23)	51 (26)	
Pathologic T-wave	32 (3)	10 (3)					32 (5)	10 (5)	
Other	126 (11)	29 (9)					126 (18)	29 (15)	
Unknown	64 (6)	22 (7)					64 (9)	22 (11)	
RBBB + ST-depression	106 (9)	28 (9)					106 (15)	28 (14)	
Investigations and treatment									
Early CAG	529 (45)	130 (40)	0.08	320 (69)	82 (65)	0.38	209 (30)	48 (24)	0.12
PCI, % of patients treated with early CAG	364 (69)	82 (63)	0.21	241 (75)	62 (76)	P = 0.96	123 (59)	20 (42)	0.03
	n = 516	n = 128	P-value	n = 311	n = 82	P-value	n = 205	n = 46	P-value
CAG findings			0.02			0.11			0.01
Normal findings or ateromatosis	84 (16)	32 (25)		38 (12)	11 (13)		46 (22)	21 (46)	
1-vessel disease	185 (36)	49 (38)		122 (39)	36 (44)		63 (31)	13 (28)	
2-vessel disease	107 (21)	29 (23)		66 (21)	24 (29)		41 (20)	5 (11)	
3-vessel disease	100 (19)	12 (9)		63 (20)	9 (11)		37 (18)	3 (7)	
LMCA stenosis[b]	40 (8)	6 (5)		22 (7)	2 (2)		18 (9)	4 (9)	
At least one significant lesion	432 (84)	96 (75)	0.02	273 (88)	71 (87)	0.77	159 (78)	25 (54)	0.001

Abbreviations: LBBB, left bundle branch block; RBBB, right bundle branch block; LMCA, left main coronary artery.
[a] Statistics are calculated on all patients (n = 1498) unless otherwise indicated.
[b] LMCA stenosis plus 0, 1, 2 or three diseased vessels.

known atrial fibrillation and heart failure were negatively associated with early CAG in the ST-elevation/LBBB group, as were ischaemic heart disease in the group without ST-elevation/LBBB. Odds ratios and 95% confidence intervals are presented in Table 3.

Outcome

There was no difference between men and women in survival at 30 days, 6 months or 1 year regardless of first registered ECG (Table 4).

Discussion

To the best of our knowledge this is the first report of gender specific CAG findings after OHCA. In our large national observational study of 1498 consecutive patients with successfully resuscitated OHCA victims, we found no gender differences in the proportion of ECG findings strongly indicating coronary ischaemia, i.e. ST-elevation or LBBB. Despite this, men had more left main coronary artery stenosis and 3-vessel disease, while women more often had normal coronary angiographic findings.

There were no gender differences in the proportion of ECG findings strongly advocating early CAG, i.e. ST-elevation or LBBB. We lack information on whether the LBBBs were presumed new or not. Nonetheless, in our analysis they are all classified as possibly new. In contrast to current guidelines,[25] recommendations to consider reperfusion strategies during the study period included only those LBBBs presumed to be new.[26,27] Further analysis of our population showed that fewer patients with LBBB, compared to ST-elevation, had CAG leading to PCI. This is in accordance with previous findings that even a newly discovered LBBB is a poor predictor of ACS.[28,29] Also, more patients with LBBB had previous ischaemic heart disease, suggesting that LBBB may be viewed as a marker of pre-existing disease. These patients underwent early CAG less often, suggesting

that many LBBBs are not newly discovered, but this is merely speculation.

In contrast to the 2010 guidelines, those in 2005 did not recommend immediate CAG if no ST-elevation or presumably new LBBB was present. Given that women have ST-elevation on post-resuscitation ECG less often[18] there is reason to believe more women underwent early CAG after 2010, but to what extent, if any, the different guidelines affected our results we do not know.

In keeping with what is known from ACS and suspected coronary artery disease (CAD),[30,31] our results suggest that men have more severe CAD. Still, this was only seen in patients without ST-elevation/LBBB where men more often had at least one significant stenosis and PCI following CAG. They also had a lower proportion of normal CAG findings. Our results may be affected by more women with ACS having non-obstructive CAD, resulting in normal angiograms.[32,33] Our findings underline the challenge of referring patients without ST-elevation/LBBB for CAG, balancing potential benefits vs. unwanted risks, and possibly the first registered ECG after ROSC may add some information about whether to refer for CAG or not. The lack of gender differences in the ST-elevation/LBBB group regarding the proportion of significant lesions may indicate that this is a group associated with having a cardiac origin of the OHCA and thereby that there are fewer differences in characteristics between men and women.

Previous studies have examined the association of gender and early CAG after OHCA in populations including non-traumatic arrests[10] or arrests of presumably cardiac origin[11,12] finding women less likely to be investigated with early CAG. We only included patients with an initially shockable rhythm, in contrast to the former studies, which may, at least partly, explain why no association between gender and use of early CAG was seen in our study, regardless of ECG after ROSC.

Increasing age, previously known atrial fibrillation and heart failure in the ST-elevation/LBBB group and previously known ischaemic heart disease among patients without ST-elevation/LBBB was

Table 3 – Multivariable analysis. Factors associated with early CAG.[a]

Variable	ST-elevation or LBBB (n = 558)			No ST-elevation or LBBB (n = 846)		
	OR	95% CI	P-value	OR	95% CI	P-value
Female gender	0.85	0.53–1.36	0.49	0.74	0.50–1.10	0.14
Increasing age, per year	0.97	0.95–0.99	<0.001	0.99	0.98–1.01	0.25
Hypertension	1.53	0.89–2.63	0.13	1.51	0.99–2.28	0.053
Diabetes	1.19	0.57–2.49	0.64	0.80	0.47–1.37	0.41
Ischaemic heart disease	0.70	0.39–1.26	0.24	0.41	0.24–0.69	0.001
COPD	0.39	0.12–1.26	0.12	1.08	0.46–2.53	0.86
Atrial fibrillation	0.40	0.20–0.80	0.010	0.63	0.37–1.07	0.09
Heart failure	0.36	0.18–0.72	0.004	0.57	0.32–1.02	0.06
Kidney failure	0.86	0.22–3.40	0.83	0.68	0.22–2.11	0.51
Stroke	0.54	0.20–1.47	0.23	0.80	0.40–1.62	0.54
Cancer	0.57	0.29–1.15	0.12	0.94	0.56–1.56	0.80
Bystander CPR	1.19	0.73–1.93	0.48	0.88	0.59–1.29	0.50
Witnessed OHCA	0.55	0.26–1.16	0.12	1.74	0.89–3.41	0.11
Crew-witnessed OHCA	4.43	1.96–10.02	<0.001	0.85	0.44–1.62	0.62
Increased EMS response time, per minute	1.00	0.97–1.02	0.70	1.00	0.97–1.03	0.83
OHCA at home	0.87	0.58–1.31	0.51	0.90	0.66–1.24	0.53

Abbreviations: OR, odds ratio; CI, confidence interval; COPD, chronic obstructive pulmonary disease; CPR, cardiopulmonary resuscitation; OHCA, out-of-hospital cardiac arrest; EMS, emergency medical services.

[a] Only patients with complete data was included in the analysis. 5.9% of cases in the ST-elevation/LBBB group and 6.5% in the group without ST-elevation/LBBB had missing data.

Table 4 – Outcome data. Data are presented as No. (%) of participants.

	Total population (n = 1498)			ST-elevation or LBBB (n = 593)			No ST-elevation or LBBB (n = 905)		
	Men	Women	P-value	Men	Women	P-value	Men	Women	P-value
30-days survival	644 (55.0)	177 (54)	0.78	277 (59)	69 (54)	0.30	367 (52)	108 (54)	0.63
6-months survival	612 (52)	169 (52)	0.85	265 (57)	65 (51)	0.25	347 (49)	104 (52)	0.49
1-year survival	597 (51)	164 (50)	0.79	260 (56)	63 (50)	0.22	337 (48)	101 (51)	0.50

associated with lower use of early CAG. Maybe this reflects advanced disease and low expectations of successful revascularization. Crew-witnessed OHCA was associated with early CAG in patients with ST-elevation/LBBB. This may be due to higher expectations of successful revascularization reflected by a short time to ROSC and greater probability of well-performed cardio-pulmonary resuscitation.

No gender differences in survival at 30 days, 6 months or 1 year were seen regardless of first ECG. This differs from several studies with more unselected OHCA populations, where women have worse outcome.[11,13,17,18] This may, at least partly, be an effect of our intentions to investigate a population with a high proportion of cardiac arrests of cardiac origin. This is supported by a recent meta-analysis[34] which shows that women have increased odds of survival in cases with a presumed cardiac origin.

Consistent with previous reports,[16,22,23,35] regardless of ECG, women had OHCA at home more often. They had longer EMS response time, but only in the group without ST-elevation/LBBB. Reasons for this could only be speculative or by chance. Only among patients without ST-elevation/LBBB were more men deemed to have a cardiac aetiology underlying the OHCA. This information is based on the paramedics' assumptions, and regardless of how experienced they are, there is always a possibility of them being influenced by the first ECG and initial care at the emergency department, since this difference was not seen in the group with no ST-elevation/LBBB.

We chose to compare early CAG and cases without early CAG. The latter group included both patients not investigated with CAG at all and those investigated after the day of the OHCA but no later than 4 weeks from the OHCA. We suspected that patients investigated with CAG later than on the day of the arrest were a robust group with good survival prospects and a promising prognosis already at the time for the CAG. Also, one may suspect that much more information was available in cases of late CAG, thereby eliminating some of the difficulties with the initial treatment after OHCA. By including only comatose patients, we intended to describe a population frequently encountered at admission with less available background history and several possible origins of the arrest, making decisions regarding proper immediate treatment, including referral for immediate CAG a challenge for the treating physician.

We acknowledge several limitations. Our CAG findings are derived from a group of patients already referred to the catheterization laboratory. We do not know how the proportions of CAG and PCI would have been affected if all patients had been referred to larger centres with catheterization facilities open around the clock, which may lead to patients being referred who would not otherwise have been. Also, we do not know if LBBBs on first ECG were previously known or not. Unfortunately, we do not have information on culprit lesions. We do not know to what extent our results reflects the years with earlier guidelines recommending CAG or thrombolysis only when evidence of coronary occlusion, i.e. ST-elevation or LBBB was present.[26] Unfortunately, we have no information regarding target

temperature management. Moreover, we cannot tell to what extent "obvious non-cardiac causes" were present. Finally, we assume that we have missed some early CAGs performed during the first hours of the day following the cardiac arrest, but to what extent this affected our results we do not know.

However, we have a solid number of patients with low numbers of missing data. The Swedish Register for Cardio-Pulmonary Resuscitation covers close to 100% of hospitals in Sweden with all Ambulance services connected. Complementary data was extracted from well-known high-quality registries.

Summary/conclusion

We investigated a population of OHCA with an expected high proportion of presumed cardiac aetiology. Our results suggest that, despite the fact that no gender differences in proportions of ECG findings indicating ischaemia were found, men seem to have more severe coronary artery disease while women more frequently have normal angiography findings. Despite this, no gender difference was seen in survival up to 1 year. Female gender was not associated with the utilization of early CAG. Further studies are needed to identify those patients who will benefit most from early CAG after cardiac arrest, or alternatively to identify those patients where we should look for other reasons to the cardiac arrest.

Conflict of interest

None.

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