Australasian Emergency Care 25 (2022) 213–218

Contents lists available at ScienceDirect

Australasian Emergency Care

journal homepage: www.elsevier.com/locate/auec

Research paper

Factors associated with time delay to angiography in acute ST-elevation myocardial infarction - A retrospective cohort study in Northern Finland

Mia K. Aitavaara-Anttila[a,b,*], Heini H. Pernu[c,1], Tuuli K. Rumpunen[d,1], Jani P.O. Similä[e], Janne H. Liisanantti[a,f], Timo I. Kaakinen[a,f], Tiina M. Erkinaro[a,f], Lasse V. Raatiniemi[a,e]

[a] Research Group of Surgery, Anesthesiology and Intensive Care, Division of Anesthesiology Oulu University Hospital, Medical Research Centre, University of Oulu, Oulu, Finland
[b] Rovaniemi Health Center, Rovaniemi, Finland
[c] Jokilaakso rescue department, Ylivieska, Finland
[d] Oulu-Koillismaa rescue department, Oulu, Finland
[e] Centre for Pre-Hospital Emergency Care, Oulu University Hospital, Oulu, Finland
[f] Department of Anesthesia and Intensive Care, Oulu University Hospital, Oulu, Finland

ARTICLE INFO

Article history:
Received 5 August 2021
Received in revised form 4 November 2021
Accepted 4 November 2021

Keywords:
Pre-hospital care
Emergency medical services
ST-elevation myocardial infarction
Delayed treatment

ABSTRACT

Background: The delay of percutaneous coronary intervention increases the risk of heart failure and mortality in STEMI. The aim of this study was to examine the time intervals of EMS and the factors associated with the time delay to angiography in patients with STEMI.
Methods: The present study was conducted in Northern Ostrobothnia, Finland in 2014–2016. All patients transported to the hospital by EMS who were diagnosed with STEMI and underwent a primary angiography within 24 h of arrival were included. Angiography was defined as delayed if it was performed over 120 min of the first medical contact (FMC).
Results: 310 patients met the inclusion criteria during the study period. Time from the FMC to angiography was less than 120 min in 231 patients (74.5%). In multivariate analysis, the factors associated with delayed angiography were the absence of chest pain (OR 2.46 (1.18–5.13),p = 0.016), dyspnea (OR 3.11 (1.54–6.28),p = 0.002), the treatment protocol violations by EMS (OR 2.41 (0.99–5.80),p = 0.050), treatment initiation at a primary health care center (OR 3.64 (1.39–9.48),p = 0.008), and the distance to hospital of over 100 km (OR 11.87 (6.14–22.93),p < 0.001).
Conclusion: In our study, treatment protocol violations, non-specific symptoms, and the distance to hospital of over 100 km were associated with primary angiography in patients with STEMI transported to the hospital by EMS.

1. Introduction

Managing chest pain is a common mission (11–16.4%) [1,2] for emergency medical service (EMS) but only 3.4% of the patients presenting with this symptom are diagnosed with an acute ST-elevation myocardial infarction (STEMI). [2] The annual incidence of STEMI varies between 42 and 146 cases per 100 000 persons in Europe and the in-hospital mortality is 4.2–13.5% [3]. A delay of percutaneous coronary intervention (PCI) increases the risk of heart failure and mortality in STEMI [4–6]. A large meta-analysis showed that the delays in pre-hospital treatment and transportation are strongly associated with the total delay of PCI.[7] Furthermore, an earlier study from Austria showed that the location and age of the patient, and the time of day, have an impact on the pre-hospital delays in STEMI patients [8].

The European Society of Cardiology (ESC) and the Finnish current care guidelines recommend that the delay from the first medical contact (FMC) to PCI should be less than 120 min in patients with STEMI [9,10]. We assume that in Northern Finland, however, the time delay to PCI may be longer due to limited number of hospitals and long distances. According to the treatment protocol, the patients with suspected acute coronary syndrome are treated on scene by paramedics, and HEMS physicians or cardiologists are consulted by

* Correspondence to: Department of Anesthesia and Intensive care, Lapland Central Hospital, Ounasrinteentie 22, 96400 Rovaniemi, Finland.
E-mail address: mia.aitavaara@student.oulu.fi (M.K. Aitavaara-Anttila).
[1] Equal contribution, MHC= Master of health care

https://doi.org/10.1016/j.auec.2021.11.003
2588-994X/

phone. After the initial treatment, the patients are transported directly to a central hospital with intervention cardiology facilities instead of smaller hospitals or primary health care centres. If the time frame to PCI is estimated to be longer than 120 min, both the ESC and the Finnish guidelines recommend that immediate fibrinolysis should be commenced if STEMI is suspected [9,10].

The aim of this study was to examine the time intervals of EMS in patients with STEMI, and the factors associated with the time delay from the FMC to angiography in Northern Finland. Furthermore, the effect of delayed angiography to short- and long-term mortality was investigated.

2. Methods

This was a retrospective observational cohort study in Northern Ostrobothnia Hospital District, Finland. The study included all adult patients transported to the hospital by EMS in 2014–2016 who were diagnosed with STEMI and underwent coronary angiography within 24 h of arrival. The exclusion criteria were as follows: No signs of STEMI observed in ECG by the EMS personnel, patient transported from another hospital district, EMS did not meet the patient, patients under 18 years of age, angiography performed after 24 h of arrival to the hospital, primary fibrinolysis given, and no patient data available.

This research was done without patient or public involvement.

2.1. Setting

The population of the hospital district was 400 959 in 2017, and the land area is 45 852 square kilometres (km). Acute medical care is provided in the Oulu University Hospital and, during office hours, also in primary health care centres. The hospital provides a 24/7 on-call cardiologist service for coronary angiography and primary PCI.

The emergency response centre agency (ERCA) dispatches all EMS units in Finland. Dispatchers are not health care professionals but have a special training. Medical dispatches are categorized by four levels of priority; A, B, C and D. A and B are both considered missions where immediate medical assessment by EMS is needed, C is considered urgent, and D non-urgent. C and D priorities are used when the patient has no obvious life-threatening signs or symptoms. Transport priorities follow the same criteria, and the judgement is made by the EMS personnel on scene.

The pre-hospital response in acute chest pain consists of an ambulance staffed by paramedics or EMS technicians, and of first response units if necessary. General practitioners (GP) or Helicopter emergency medical service (HEMS) are not routinely involved in the pre-hospital dispatch protocol in the study area. However, the HEMS physician or a cardiologist should be consulted if the EMS providers suspect prehospital STEMI.

2.2. Data extraction

Data were extracted from the Oulu University Hospital electronic database and the EMS database. The variables obtained from the hospital database were age, sex, chronic illnesses, the place of residence, the hospital length of stay and the 30-day outcome of the patient. Finnish population data services were used to obtain information about long term mortality. From the EMS mission data, the urgency of the dispatch and mission, the day of the week, the time of day, different time intervals, and the first location of treatment was collected. Information on ECG findings, symptoms, vital parameters, possible cardiac arrest, the National Early Warning score (NEWS), the violations of the treatment protocol by EMS, and whether a HEMS physician was called to the scene was also extracted. The patients were divided by the NEWS score to low and high-risk patients. The classification was based on the recommendation by the Royal College of Physicians [11].

2.3. Definitions

Angiography was defined as delayed if it was started later than 120 min of the FMC. The ESC recommends using the time from FMC to balloon, but we were not able to obtain this data [9].

2.4. Statistics

SPSS software (SPSS for Windows) (IBM Corp., 2013; IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY, USA) was used for statistical analysis. Proportional data are presented as numbers and percentages (%) and continuous variables as medians with 25th and 75th percentiles. Continuous variables were tested using the non-parametric Mann-Whitney test, whereas the Pearson's chi-square was used for categorical data. A two-tailed *P* value less than 0.05 was considered statistically significant. Logistic regression analysis was used to calculate the ORs for delayed angiography. All variables with univariate significance less than 0.1 (Dyspnea, Disorder of consciousness, Chest pain at EMS encounter, Pre-hospital notification, First transportation, Distance to Oulu University Hospital, Time from FMC to angiography, Transport type, Transport priority, Mission type) and age and sex were included into the model using the enter method and were retained if statistically significant, or if they had a significant impact on the log likelihood function. Missing data is presented in the tables. 24 patients were excluded from the analysis because of missing data. This is presented in Fig. 1.

2.5. Results

2.5.1. Patient characteristics

The total number of patients who underwent angiography or PCI or had STEMI between January 1st, 2014 and December 31st, 2016 was 3480. Patients receiving primary fibrinolysis (23 patients) were excluded. After exclusion, the total number of the included patients was 310 (Fig. 1.).

The patient characteristics are shown in Table 1. The median age of the patients was 65 [56–74] and 67 [60–75] years in the non-delayed and delayed groups, respectively ($P = 0.021$). The groups were similar in terms of sex and chronic illnesses. Male sex was overrepresented in both groups by about 71%. 21.2% of the non-delayed and 24.1% of the delayed patients had a prior diagnosis of coronary artery disease.

2.5.2. EMS missions

The details of the EMS missions are shown in Table 2. The time delay to angiography was less than 120 min in 231 (74.5%) patients (Table 1). The median time from the FMC to angiography was 68 [51–92] minutes in the non-delayed group and 153 [135–187] minutes in the delayed group. In both groups, the urgency of dispatch was most often B. 'Chest pain' as a dispatch code was more common in the non-delayed group (55.8% vs. 43.0%, $P < 0.001$). In the non-delayed group, the patients were transported more often straight to the catherization laboratory (87.0% vs 39.2%, $P < 0.001$). Furthermore, the pre-hospital notification was missing in 60.8% of the delayed patients compared with only 13.0% of the non-delayed patients. The median distance to Oulu University hospital was 37 km [11–88] in the non-delayed group and 131 km [88–163] in the delayed group ($P < 0.001$).

2.5.3. Symptoms and parametres

Chest pain at EMS encounter was more common in the non-delayed group than in the delayed group (85,3% and 72.2%, $P = 0.009$),

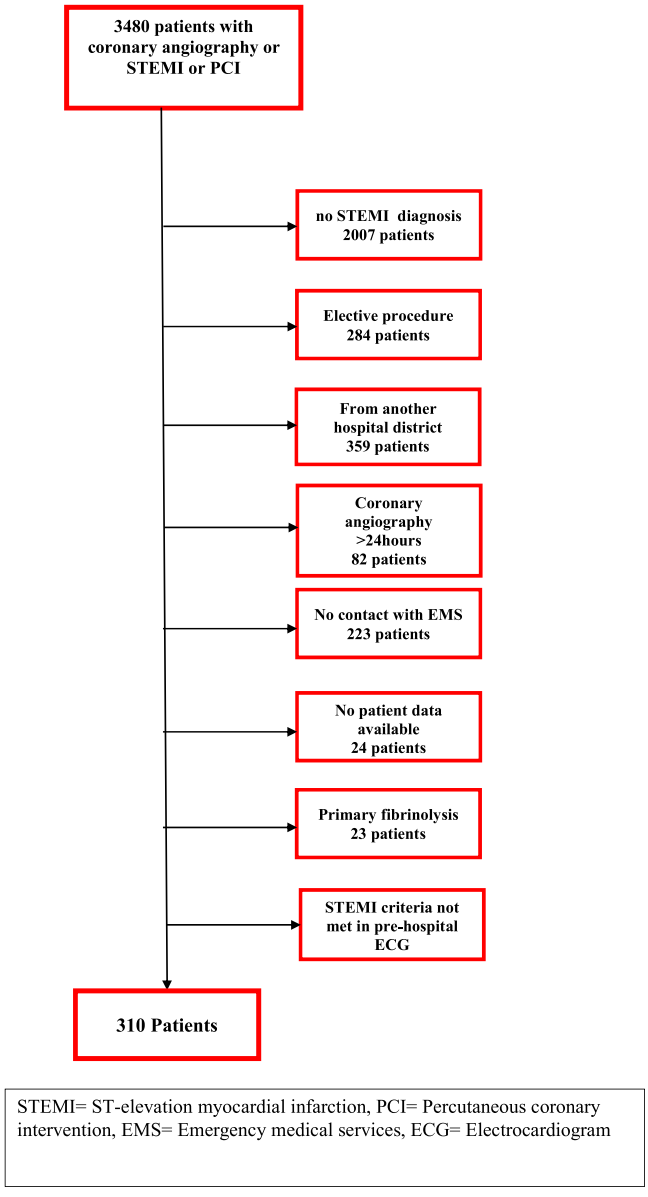

Fig. 1. Flow chart of study population.

while dyspnea was more common in the delayed group (17.3% and 32.9%, $P = 0.006$). There were no significant differences between the groups in other signs and symptoms, the NEWS scores, or vital parametres (Table 3.).

2.5.4. Multivariate analysis

The results of the logistic regression analysis are shown in Table 4. The absence of chest pain, dyspnea as a symptom, treatment protocol violations, treatment started by a general practitioner, and the distance to hospital of over 100 km, were associated with the time delay to angiography.

2.5.5. Outcome

The hospital length of stay did not differ between the two groups (2 [2,3] days, $P = 0.893$). 30-day mortality was 6.1% in the non-delayed group and 10.1% in the delayed group ($P = 0.228$).

3. Discussion

3.1. Main results

The main finding of the present study is that both system and patient-related factors as well as long transportation distances to angiography are related to treatment delays in patients with STEMI. The delays are linked to symptoms unspecific to STEMI and to protocol violations.

3.2. Interpretation

We found two clear patient-related factors associated with treatment delays: the absence of chest pain, and dyspnea as a main symptom. Previous studies have not been focusing on symptoms linked to pre-hospital delays. Emergency department delays have been associated with atypical symptoms [12].

Patients with STEMI presenting without chest pain are at a greater risk for morbidity and mortality and should be recognised early [13–15]. The diagnosis of STEMI is based on ECG findings but clinical characteristics also play a major role [16]. Moreover, dyspnea is a highly unspecific symptom and can be related to several other conditions, such as sepsis or respiratory failure [17]. We hypothesize that unspecific symptoms may lead to other diagnostic challenges during the treatment process and, therefore, cause treatment delays.

The distance from the scene to the hospital was significantly associated with delayed angiography. Results are from an area with long distances to the hospital, but most of the patients live within 100 km from hospital. The majority of the patients in the delayed group should have received thrombolysis based on the geographical facts. Fibrinolysis and HEMS transportation should be considered when distance to hospital is >100 km.

Our study could not detect any differences in the short-term mortality between the two groups. Most of the patients in the delayed group underwent angiography within three hours, which may explain the comparable short term survival. In addition, only few patients were resuscitated. Although the ESC recommends immediate fibrinolysis if PCI is not available in two hours, myocardial salvage still occurs at least up to 12 h [9,18,19]. Previous studies have

Table 1
Patient characteristics.

	Delay < 120 min N = 231	Delay > 120 min N = 79	Missing data	P-value
Sex (M/F) (M%)	**165/66 (71.4)**	**56/23 (70.9)**	**0**	**0.927**
Age	**65 [56–74]**	**67 [60–75]**	**0**	**0.201**
MCC	**49 (21.2)**	**19 (24.1)**	**0**	**0.599**
HTA	**83 (35.9)**	**25 (31.6)**	**0**	**0.490**
CHF	**5 (2.2)**	**4 (5.1)**	**0**	**0.185**
Hypercholesterolemia	**32 (13.9)**	**8 (10.1)**	**0**	**0.394**
T1D	**4 (1.7)**	**4 (5.1)**	**0**	**0.107**
T2D	**25 (10.8)**	**8 (10.1)**	**0**	**0.863**
COPD	**16 (6.9)**	**6 (7.6)**	**0**	**0.842**

MCC = Morbus cordis coronarius, HTA= Hypertension artérielle, CHF= Chronic heart failure, T1D= Type 1 diabetes, T2D= Type 2 diabetes, COPD = Chronic obstructive pulmonary disease

Table 2
Mission data.

	Delay < 120 min N = 231	Delay > 120 min N = 79	Missing data	P-value
Dispatch Criteria	**67 (29.0)**	**18 (22.8)**	**0**	**0.604**
A	**133 (57.6)**	**47 (59.5)**		
B	**28 (12.1)**	**12 (15.2)**		
C	**3 (1.3)**	**2 (2.5)**		
D				
Mission	**129 (55.8)**	**34 (43.0)**	**0**	**<0.001**
Chest pain	**59 (25.5)**	**26 (32.9)**		
Transfer	**43 (18.6)**	**19 (24.1)**		
Other				
Transport priority	**174 (75.3)**	**38 (48.1)**	**0**	**<0.001**
A	**57 (24.7)**	**41 (62.8)**		
B-C				
Transport	**171 (74.0)**	**42 (53.2)**	**0**	**<0.001**
Chest pain	**58 (25.1)**	**30 (38.0)**		
Transfer	**2 (0.9)**	**7 (8.9)**		
Other				
Time of dispatch	**71 (30.7)**	**20 (25.3)**	**0**	**0.361**
Weekend	**168 (72.7)**	**59 (74.7)**	**0**	**0.735**
Day time	**120 (51.9)**	**44 (55.7)**	**0**	**0.565**
Office hours				
Scene	**139 (60.2)**	**47 (59.5)**	**0**	**0.259**
Home	**28 (12.1)**	**5 (6.3)**		
Public place	**64 (27.7)**	**27 (34.2)**		
Health care unit				
Time interval	**3** [2–9]	**2** [2–11]	**39**	**0.047**
Time from dispatch to patient	**68 [51–92]**	**153 [135–187]**		
Time from FMC to angiography				
Distance to Oulu University Hospital	**37** [11–88]	**131 [88–163]**	**0**	**<0.001**
First transportation	**2 (0.9)**	**14 (17.7)**	**0**	**<0.001**
Health care centre	**28 (12.1)**	**34 (43.0)**		
ER at Oulu university hospital	**201 (87.0)**	**31 (39.2)**		
Catherization lab				
Pre-hospital notification	**201 (87.0)**	**31 (39.2)**	**0**	**<0.001**
HEMS physician at the scene	**24 (10.3)**	**14 (9.5)**	**0**	**0.769**
Physician consulted	**163 (70.6)**	**49 (62.0)**	**14**	**0.371**
HEMS physician	**59 (25.5)**	**26 (32.9)**		
Assessment made by GP at health care centre				
Treatment protocol was followed	**53 (22.9)**	**10 (12.7)**	**0**	**0.115**
Yes	**119 (51.5)**	**43 (54.4)**		
No	**59 (25.5)**	**26 (32.9)**		
Treatment started at health care centre or regional hospital				

Table 3
Patient physiological parametres.

	Non-delayed group < 120 min N = 231	Delayed group >120 min N = 79	Missing data	P -value
Chest pain at EMS encounter	**197 (85.3)**	**57 (72.2)**	**0**	**0.009**
Dyspnea	**40 (17.3)**	**26 (32.9)**	**0**	**0.006**
Cold Sweat	**47 (20.3)**	**14 (17.7)**	**0**	**0.612**
Disorder of Consciousness	**17 (7.4)**	**11 (13.9)**	**0**	**0.079**
Skin paleness	**24 (10.4)**	**10 (12.7)**	**0**	**0.578**
Feeling of arrhythmia	**4 (1.7)**	**2 (2.5)**	**0**	**0.656**
Lifelessness	**19 (8.2)**	**5 (6.3)**	**0**	**0.586**
Systolic Blood Pressure (mmHg)	148 [121–171]	155 [130.5–172.5]	16	0.137
Heart rate (BPM)	77 [64–91]	79.5 [60.5–100]	6	0.289
Respiration rate (BPM)	**16** [15–20]	**17** [15–20]	**150**	**0.640**
$NEWS_{lowrisk}$	**160 (69.3)**	**55 (69.6)**	**0**	**0.672**
$NEWS_{mediumrisk}$	**40 (17.3)**	**11 (13.9)**	**0**	**0.672**
$NEWS_{highrisk}$	**31 (13.4)**	**13 (16.5)**	**0**	**0.672**
NEWS score	2 [1–4]	2 [1–5]	0	0.519
Any supplemental Oxygen (NEWS)	0 [0–2]	0 [0–2]	0	0.129
Oxygen saturations % (NEWS)	0[0]	0 [0]	0	0.808
GCS	15 [15]	15 [15]	0	0.825

reported similar results. A longer waiting time to angiography and PCI leads to a larger infarct size and heart failure, and is therefore associated with increased mortality. [5,20].

Assessment by a GP in a primary health care centre was strongly associated with a delay in multivariate analysis, which is in accordance with previous results [9,21]. This again can be explained

Table 4
Multivariate analysis for PCI > 120 min and univariate analysis of variables included.

nivariate analysis	OR (95%CI)	P-value
Absence of chest pain	2.24 (1.21–4.12)	0.009
Dyspnea as a symptom	2.34 (1.31–4.18)	0.006
Treatment protocol not followed	1.12 (0.67–1.88)	0.115
Assessment at health care centre	1.43 (0.82–2.49)	0.371
Sex (female)	0.97 (0.55–1.71)	0.927
Distance to hospital over 100 km	9.22 (5.10–16.66)	<0.001
Multivariate analysis		
Absence of chest pain	2.46 (1.18–5.13)	0.016
Dyspnea as a symptom	3.11 (1.54–6.28)	0.002
Treatment protocol not followed	2.41 (0.99–5.80)	0.050
Assessment at health care centre	3.64 (1.39–9.48)	0.008
Age	1.01 (0.98–1.04)	0.469
Sex (female)	1.06 (0.53–2.11)	0.875
Distance to hospital over 100 km	11.87 (6.14–22.93)	<0.001

simply by the additional time spent during the transportation and physician assessment compared to the situation where STEMI is recognized by EMS and the patient is transported straight forward to angiography. EMS also has its treatment protocol when STEMI is suspected, making the treatment and outcome more proficient. Prehospital notification was associated with earlier angiography. A previous study reported that the pre-notification of the catheterization laboratory by EMS reduces the door to balloon time by an average of 35 min compared to no pre-alerting [22]. Physician consultation has been shown to decrease the delay with traumatic brain injury (TBI) patients in Finland [23]. All though our study could not detect this, physician consultation for was more common in non-delayed group.

3.3. Strengths and limitations

The study population is relatively small, which may limit the generalizability of our results, and the power to detect differences in mortality. Also, as an observational study, the association with the long-term mortality is difficult to interpret. However, our patient groups were similar in age and in the incidence of chronic illnesses, and represent a typical sample of STEMI patients in northern Finland.

The study design was retrospective with all possible sources of bias. However, multivariate analysis was used to mitigate potential selection bias. The study was conducted in a large geographical area with a sparse population and, therefore, care should be taken before extrapolating the results to urban areas with short distances. Distance to the hospital was the most significant factor associated to delays, which is an obvious finding. Unfortunately, the further analysis to study impact on outcome, was not possible due to limited number of patients. The Finnish and other Nordic health care systems are unique which may have a significant impact on organizational factors shown in our study. We found treatment by GP strongly associated with the delay but we were unable to interpret if this was because of STEMI was not identified or because the EMS-unit was dispatched to GP to assist in the treatment. Also, we did not have the content of the recommendation by HEMS physician which is a limitation. Information about resource availability of the catheterization laboratory was not available for the analysis, which may have had an impact on the results. Finally, ECGs were not analysed in the study, but they had been analysed by a physician in most cases during the treatment. The diagnosis of STEMI was based on patient medical documents.

3.4. Clinical impact

Purpose of the study was to examine factors associated with the delayed angiography. We found atypical symptoms and long distance strongly associated with the delay. These results may help EMS-providers recognise STEMI-patients and encourage further studies on this matter. Early recognition of STEMI-patient is more important when distance to PCI-centre is long.

4. Conclusion

In the present study, most of the patients arrived at angiography within 120 min. We were able to demonstrate several patient and EMS related factors associated with the time delay from the FMC to angiography of more than 120 min. Results are from an area with long distances to the hospital and this should be taken into account when interpreting the results.

Funding

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors. The authors declare that there are no competing interests.

Acknowledgments

None of the authors have conflicts of interest. The study received no funding. Authors' contributions: JL, LR, JS, HP, TR, MA-A designed the study. JS, HP, TR collected the data. JL analysed the data. The manuscript was prepared by all of the authors after interpreting the results. MA-A submitted the study.

Disclosures

The study protocol was accepted by the hospital administration (246/2017) and, according to the local protocol, it was not necessary to obtain a statement from the human research ethics committee due to the retrospective study design.

Abstract of this study was published in Journal of Finnish society of anaesthesiologists (Finnanest) (4/20) and presented at ESICM e-lives event in December 2020.

References

[1] Møller TP-, Ersbøll AK-, Tolstrup JS-, Østergaard D-, Viereck S-, Overton J, et al. Why and when citizens call for emergency help: an observational study of 211,193 medical emergency calls. Scand J Trauma Resusc Emerg Med 2015;23:88. Doi:101186/S13049-015-0169-0 2015.
[2] Pedersen CK-, Stengaard C-, Friesgaard K-, Dodt KK-, Søndergaard HM-, Terkelsen CJ, et al. Chest pain in the ambulance; prevalence, causes and outcome - a retrospective cohort study. Scand J Trauma Resusc Emerg Med 2019;27(1):84. Doi:101186/S13049-019-0659-6 2019.
[3] Widimsky P-, Wijns W-, Fajadet J-, Belder M-, de, Knot J-, Aaberge L-, et al. Reperfusion therapy for ST elevation acute myocardial infarction in Europe: description of the current situation in 30 countries. Eur Heart J 2010:943–57.
[4] Zurowska-Wolak M-, Piekos P-, Jakala J-, Mikos M. The effects of prehospital system delays on the treatment efficacy of STEMI patients. Scand J Trauma Resusc Emerg Med 2019;27(1):39. Doi:101186/S13049-019-0616-4 2019.
[5] Nallamothu BK-, Normand SLT, Wang Y-, Hofer TP-, Brush JE, Messenger JC, et al. Relation between door-to-balloon times and mortality after primary percutaneous coronary intervention over time: a retrospective study. Lancet 2015;385(9973):1114–22. Doi:101016/S0140-6736(14)61932-2Epub 2014 Nov 19 2015.
[6] Loh JP-, Tan LL-, Zheng H-, Lau YH-, Chan SP-, Tan KB-, et al. First medical contact-to-device time and heart failure outcomes among patients undergoing primary percutaneous coronary intervention. Circ Cardiovasc Qual Outcomes 2018;11(8):E004699. Doi:101161/CIRCOUTCOMES118004699 2018.
[7] Alrawashdeh A-, Nehme Z-, Williams B-, Stub D. Emergency medical service delays in ST-elevation myocardial infarction: a meta-analysis. Heat 2019.
[8] Jager B.-, Haller PM-, Piackova E.-, Kaff A.-, Christ G.-, Schreiber W. -, et al. - Predictors of transportation delay in patients with suspected ST-elevation-myocardial infarction in the VIENNA-STEMI network. - Clin Res Cardiol2019 Jun 29 Pii: 101007/S00392–019-01520-zDoi:101007/S00392–019-01520-z 2019.
[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. Doi:101093/Eurheartj/Ehx393 2018.

[10] Working group set up by the Finnish Medical Society Duodecim and the Finnish Cardiac Society. ST-elevation myocardial infarction. Current care guidelines. Helsinki: The Finnish Medical Society Duodecim; 2011. 2011.
[11] McGinley A, Pearse RM. A national early warning score for acutely ill patients. BMJ 2012;345:e5310. https://doi.org/10.1136/bmj.e5310.
[12] Congost G.- Berga, Brugaletta S.-, Bernal J.- Valverde, López A.- Márquez, Gabalda J.- Ruiz, Garcia-Picart J., et al. The importance of organizational variables in treatment time for patients with ST-elevation acute myocardial infarction improve delays in STEMI Australas Emerg Care2020 Nov 13:S2588–994X(20) 30106–8Doi:101016/jAuec202010001 2020.
[13] Brieger D. -, Eagle KA -, Goodman SG -, Steg PG -, Budaj A. -, White K. -, et al. - Acute coronary syndromes without chest pain, an underdiagnosed and undertreated high-risk group: insights from the Global Registry of Acute Coronary Events. - Chest2004 Aug;126(2):461–469 Doi:101378/Chest1262461 2004.
[14] Eagle KA-, Goodman SG-, Avezum A-, Budaj A-, Sullivan CM-, López-Sendón J. Practice variation and missed opportunities for reperfusion in ST-segment-elevation myocardial infarction: findings from the Global Registry of Acute Coronary Events (GRACE). Lancet 2002;359(9304):373–7. Doi:101016/S0140-6736(02)07595-5 2002.
[15] Zdzienicka J-, Siudak Z-, Zawiślak B-, Dziewierz A-, Rakowski T-, Dubiel J, et al. Patients with non-ST-elevation myocardial infarction and without chest pain are treated less aggressively and experience higher in-hospital mortality. Kardiol Pol 2007;65(7):769–75. Discussion 776-7 2007.
[16] Thygesen K.-, Alpert JS-, Jaffe AS-, Simoons ML-, Chaitman BR-, White HD -, et al. - Third universal definition of myocardial infarction. - Eur Heart J2012 Oct;33(20):2551–2567 Doi:101093/Eurheartj/Ehs184Epub 2012 Aug 24 2012.
[17] Zoorob RJ-, Campbell JS. Acute dyspnea in the office. Am Fam Physician 2003;68(9). 1803-10 2003.
[18] Boersma E. Does time matter? A pooled analysis of randomized clinical trials comparing primary percutaneous coronary intervention and in-hospital fibrinolysis in acute myocardial infarction patients. Eur Heart J 2006:779–88.
[19] Boersma E-, Maas AC-, Deckers JW-, Simoons ML. Early thrombolytic treatment in acute myocardial infarction: reappraisal of the golden hour. Lancet 1996;348(9030):771–5. Doi:101016/S0140-6736(96)02514-7 1996.
[20] McNamara RL-, Wang Y-, Herrin J-, Curtis JP-, Bradley EH-, Magid DJ-, et al. Effect of door-to-balloon time on mortality in patients with ST-segment elevation myocardial infarction. J Am Coll Cardiol 2006;47(11):2180–6. Doi:101016/jJacc200512072Epub 2006 May 15 2006.
[21] Trimmel H-, Bayer T-, Schreiber W-, Voelckel WG-, Fiedler L. Emergency management of patients with ST-segment elevation myocardial infarction in Eastern Austria: a descriptive quality control study. Scand J Trauma Resusc Emerg Med 2018;26(1):38. Doi:101186/S13049-018-0504-3 2018.
[22] Cone DC-, Lee CH-, Gelder C.- Van - EMS activation of the cardiac catheterization laboratory is associated with process improvements in the care of myocardial infarction patients. - Prehosp Emerg Care2013 Jul-Sep;17(3):293–298 Doi:103109/10903127201377312Epub 2013 Mar 19 2013.
[23] Raj R, Siironen J, Kivisaari R, Kuisma M, Brinck T, Lappalainen J, Skrifvars MB. Factors correlating with delayed trauma center admission following traumatic brain injury. Scand J Trauma Resusc Emerg Med 2013;21:67. https://doi.org/10.1186/1757-7241-21-67.