UNIL | Université de Lausanne
Faculté de biologie
et de médecine

Mémoire de Maîtrise en médecine No 4331

Myocardial infarction in young patients: study of canton de Vaud primary PCI STEMI network

Etudiant
Meric Albertin

Tuteur
Prof. Eric Eeckhout
Service de cardiologie, CHUV

Expert
Prof. Lucas Liaudet
Service de médecine intensive adulte, CHUV

Lausanne, décembre 2017

Myocardial infarction in young patients: study of canton de Vaud primary PCI STEMI network

Brief Title: STEMI in young patients: study of Vaud’s pPCI network

Keywords: young, myocardial infarction, STEMI, pPCI

Address for correspondence:

Professor Eric Eeckhout, MD PhD
Cardiology Service, CHUV
1011 Lausanne, Switzerland
Tel. : +41 21 314 00 10
Email : eric.eeckhout@chuv.ch

ABSTRACT

Background:
According to the *2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation*, primary percutaneous coronary intervention (pPCI) is the recommended reperfusion strategy in patients with ST-Elevation Myocardial Infarction (STEMI) within 12 h of symptom onset and if time from STEMI diagnosis to PCI is ≤ 120 min.
Although the majority of STEMI occurs in older patients, non-negligent part concerns young patients (≤45 years old), and those patients seem to have an atypical risk factor profile, as well as a favourable prognostic.
This study aims to compare two age groups of patients who underwent pPCI for STEMI in terms of risk factors and prognostic.
Methods:
In this retrospective study, all patients that underwent pPCI for STEMI in CHUV, a Swiss tertiary university hospital, during a three-year period (in between January 2013 and December 2015) were retrospectively studied, without any exclusion criteria.
Patients were divided into two groups according to age at presentation of STEMI. The patients who were aged ≤ 45 years old were considered to be the young group, whereas the patients aged > 45 were considered to be the older group.
The two groups were compared in terms of risk factors and prognostic, using data acquired during the procedure and at 3- and 12-months follow-up.
Results:
A total of 753 patients were studied, dived into the young group (n= 63, 8.4%) and the older group (690 patients, 91.6%). Mean age was 63.89 ± 13.62 and 75.1% were men. Patients in the young group were more likely to be men than in the older group (95.2% vs 73.3%, p<0.001).
Young patients were more likely to be active smokers (78.9% vs 51.4%, p<0.001) and have a positive family history of cardiovascular disease (49.2% vs 31.1%, p=0.005), and were less likely to suffer from hypertension (17.7% vs 52.8%, p<0.001). No significant differences could be shown between age groups when it comes to diabetes (11.1% vs 19.0%, p=0.120) and dyslipidaemia (77.6% vs 72.2%, p=0.375).
Angiographic findings show a significant difference between the groups (p<0.001), with group 1 having more single-vessel lesions (63.5% vs 42.0%, p=0.001) and less 3-vessel lesions (11.1% vs 25.4%, p=0.011).
No significant difference could be found between age groups regarding hospital survival, hospital complications and at both three-month and 12-month follow-up in term of cardiovascular mortality, all-cause mortality, or complications.
A Kaplan-Meier estimate of global survival from PCI to 1-year show a difference between age groups (350.9 ± 9.8 vs 337.3 ± 3.8), although not statistically significant according to the the log-rank test (Chi-Square 1.843, df=1, p=0.175).
Conclusion:
In our study, young patient had a specific risk factor profile when opposed to their older peers. We couldn’t find any significant difference in term of prognostic during hospital stay, and at 3- and 12-month follow-up. In our study, active smoking is the only modifiable risk factor that is over-represented in young patients. Therefore, we conclude on the utmost importance, as a matter of public health, of targeting smoking, especially in young individuals, to have an impact on STEMI in this population.

INTRODUCTION

According to the *2017 European Society of Cardiology (ESC) Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation*, primary percutaneous coronary intervention (pPCI) is the recommended reperfusion strategy in patients with ST-Elevation Myocardial Infarction (STEMI) within 12 h of symptom onset and if time from STEMI diagnosis to PCI is ≤ 120 min (level 1A recommendation) [1].

Although the majority of STEMI occurs in older patients, non-negligent part concerns young patients (≤45 years old), and those patients seem to have an atypical risk factor profile, as well as a favorable prognostic.

Only few studies have focused on the specific population of young patients undergoing pPCI for STEMI [2-5].

This study aims to compare two age groups of patients who underwent pPCI for STEMI in terms of risk factors and prognostic.

Based on the literature, it is expected that young patients who undergo pPCI for STEMI will, when compared to their older peers, present a different risk factor profile, have favorable in-hospital and intermediate term outcomes and a reduced all-cause mortality rate [2-3].

More specifically, it is expected that young patients presenting with a STEMI are more likely to be men, to be active smokers, and to have positive family history of premature coronary heart disease [2-5].

This study aims to confirm those elements and verify their applicability to the swiss population, and especially to Vaud state.

METHODS

Patient population:

All patients (a total of 753 consecutive patients) that underwent pPCI for STEMI in CHUV, a Swiss tertiary university hospital, during a three-year period (in between January 2013 and December 2015) were retrospectively studied, without any exclusion criteria. Patients who didn’t gave their consent as part of the STEMI network weren’t included.

This study is purely retrospective. All necessary data came from existing databases and medical records. Used data were of two types; first clinical characteristics (age, sex, medical history), classical cardiovascular risk factors (tobacco use, hypertension, diabetes, dyslipidemia, family history), characteristics of the STEMI (localization, number of arteries involved) and short-term outcomes were acquired during hospitalization, whereas middle-term outcomes were acquired by phone at 3- et 12-month follow-up. All data were then compiled in databases of the STEMI-network (AMIRAL – Acute Myocardial Infarction Registry and Analysis Lausanne) and AMIS Plus (Acute Myocardial Infarction in Switzerland).

Patients were divided into two groups according to age at presentation of STEMI. The patients who were aged ≤ 45 years old were considered to be the young group (hereafter referred to as group 1), whereas the patients aged > 45 were considered to be the older group (group 2).

The two groups were compared in terms of risk factors and prognostic, using data acquired during the procedure and at 3- and 12-months follow-up.

<u>Statistical analysis:</u>
Continuous variables are reported as mean ± standard deviation (SD), whereas categorical variables are reported as numbers and frequencies (percentages).

Comparison of characteristics between two groups are done by using Student t-test for continuous variables (with Lavene’s Test for equality of variances) and using Pearson's Chi-Square test or Fisher’s Exact Test for categorical variables.

When values are missing (unknown), those patients weren’t included in the concerned analysis. Therefore, the number of patients (n) for each analysis can vary. However, the n numbers are always mentioned in the tables.

Cumulative incidence of prognostic events such as mortality will be evaluated using a Kaplan-Meier estimate.

A p-value <0.05 will be considered significant.

All analysis performed for this study were done using IBM Corp. Released 2016. IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY: IBM Corp.

Graphs were created in the same program, and using Microsoft Excel 2016.

<u>Ethics</u>:
This study was approved by Vaud State Ethics Committee (*Commission cantonale d'éthique de la recherche sur l'être humain, CER-VD*) on December 1st, 2015. Protocol number 425/15.

All patients received oral and written information on AMIS Plus registry and signed a written consent allowing their data to be collected and used for research purposes. They could revoke their consent at any time.

RESULTS

<u>Clinical characteristics:</u>
A total of 753 patients were studied, dived into the young group (n= 63, 8.4%) and the older group (690 patients, 91.6%). Mean age was 63.89 ± 13.62 and 75.1% were men. Clinical characteristics are summarized in table 1.

During the study period of three years, we could not see an augmentation in number of patients or in proportion of young patients. In 2013, 2014 and 2015, the number of patient and the proportion of young were 265 (8.3%), 234 (8.5%) and 254 (8.3%).

The young patients group (group 1) had a mean age of 39.90 ± 5.18. The older patients group (group) had a mean age of 66.08 ±11.94.

Patients in group 1 were more likely to be men than in group 2 (95.2% vs 73.3%, p<0.001) and to have a greater BMI, though this difference isn't statistically significant (28.08 ±5.83 vs 26.68 ± 4.25, t = 2.422, df=751 p=0.067)

Regarding typical cardiovascular risk factors, young patients were more likely to be active smokers (78.9% vs 51.4%, p<0.001) and have a positive family history (49.2% vs 31.1%, p=0.005), and were less likely to suffer from hypertension (17.7% vs 52.8%, p<0.001). No significant differences could be shown between age groups when it comes to diabetes (11.1% vs 19.0%, p=0.120) and dyslipidaemia (77.6% vs 72.2%, p=0.375). Furthermore, an analysis of overweight, obesity, alcohol consumption, cocaine use or anabolic substance use couldn't show any significant difference.

Remark on smoking status: The results presented (78.9% vs 51.4%, p<0.001) concern active smokers compared to never smokers (former smokers were ignored for this analysis). For comparison, we also did the same analysis considering former smokers as never smokers (73.8% vs 39.4%, p<0.001) and considering them as active smokers (80.3% vs 37.3%, p=0.006). Remark on family history: defined as coronary heart disease (CHD) in a first-degree parent before 60 years old

Older patients were more likely to have personal antecedent of angina (11.3% vs 1.6%, p=0.017) and more likely to have had a PCI in the past (15.6% vs 6.3%, p=0.048).

When it come to the localization of the STEMI as visualised on the ECG, we couldn't see any significant difference between age groups.

On the other hand, angiographic findings show a significant difference between the groups (p<0.001), with group 1 having more single-vessel lesions (63.5% vs 42.0%, p=0.001) and less 3-vessel lesions (11.1% vs 25.4%, p=0.011). No difference should be shown in 2-vessel lesions (22.2% vs 32.3%, p=0.099).

An echocardiography has been done in 575 patients (77.3%) and the results of the left ventricular ejection fraction (LVEF) stratified in 3 categories (>40%, 30-40%, <30%). We couldn't see any significant difference between age groups.

<u>Short term outcomes:</u>
No differences in procedural complications could be shown (no-reflow/slow-flow, other vessel occlusion, coronary perforation, infarction, emergency CABG, rhythm disorders), except for the number of pericardial drainage being greater in group 1 (1.6% vs 0.1%, p=0.033).

No significant difference could be find between age groups regarding hospital survival (96.8% vs 94.6%, p=0.453) or length of stay at hospital (5.61 ± 8.27 vs 6.29 ± 13.66, t = 0.385, df=710, p=0.700).

No differences could be found between age groups in term of hospital complications (ICU stay, continuing care stay, AV block, cardiogenic shock, ischemia, new MI, stroke, renal failure, haemorrhage).

A total number of 39 patients (5.2%) died during hospital stay (2 patients in group 1 and 37 in group 2), among which 3 (0.4%) died during PCI. Age range amongst patients that died during hospitalisation was 16-91 and mean age at death was 70.51 ± 14.72. Mean hospital stay length at death in days was 10.08 ± 30.07 with a range of 0-187.

Short term outcomes are summarized in table 2.

Medium term outcomes:

The three-month follow-up included 391 patients, whereas the 12-month follow-up included 483. At both, no difference in term of cardiovascular mortality, all-cause mortality, or complications could be found between age groups. Detailed results are presented in table 3.

The total number of all-cause deaths during the first 12 months was 59 (11.2%) and the total number of cardiovascular deaths was 25 (5.0%). Only two out of the 59 deaths concerned young patients, and those both happen during hospitalisation (none of the young patients died during follow-up).

The cumulative all-cause mortality rate at 12 months was 4.8% in group 1 and 11.7% in group 2, whereas the cumulative cardiovascular mortality rate at 12 months was 0% in group 1 and 5.5% in group 2, although those differences between age groups aren't statistically significant ($p = 0.169$ and $p=0.129$).

Details results about death are presented in table 4.

A Kaplan-Meier estimate of global survival from PCI to 1-year follow up in days show a difference between age groups (350.9 ± 9.8 vs 337.3 ± 3.8), although the log-rank test indicates that this difference isn't statistically significant (Chi-Square 1.843, df=1, p=0.175). Survival curves are presented in Figures 12 and 13.

Treatments:

When looking at the major treatments (Dual Antiplatelet Therapy = DAPT, Beta blocker, angiotensin-converting-enzyme inhibitor = ACEI, Angiotensin II receptor blocker = ARB, Statin) when leaving hospital, and at 3 and 12-month follow-up, we observe globally good adherence in treatment, without any important differences between age groups. We can only observe a massive drop of DAPT use over time in both young and old patients, with less than 1 in 2 patients still taking this treatment at 12-month. Results are presented in Table 5 and Figures 14 and 15.

Secondary prevention:

At both 3- et 12-months follow-up, 6 items regarding habits and lifestyle changes were evaluated. No statistically significant differences could be shown between age groups. At 3- et 12-month respectively, 49.5% and 54.1% controlled their weight (defined as BMI 18.5-24.9 or significant weight loss), 74.7% and 66.4% were practicing physical activity (defined as ≥30min, 3-4x/week), 56.7% and 48.5% stopped smoking, 85.8% and 97.1% controlled their blood pressure (defined as BP ≤140 mmHg, ≤ 130mmHg if diabetic), 69.8% and 86.3% controlled their lipid profile (defined as LDL-cholesterol ≤1.8 mmol/l), 48.6% and 78.8% of diabetic patients controlled their glycemic profile (defined as HbA1c < 7%). Detailed results according to age groups are presented in Table 6.

DISCUSSION

This retrospective study of 753 consecutive patients who underwent pPCI for STEMI in CHUV (a Swiss tertiary university hospital) produced a few important findings.

First, when compared to their older peers, we found that young patients (≤45 years old) have a different risk factor profile. They were more likely to be active smokers and have positive family history, and less likely to suffer from hypertension. No significant differences could be found in diabetes and dyslipidaemia.

Second, young patients have more single-vessel disease.

Third, when it comes to prognosis, we didn't find significant differences in young patients, neither in term of in-hospital complications, nor at 3 and 12-month follow up. Literature clearly shows that young patients have a better prognostic after pPCI for STEMI [2-4]. Our results go in this direction too, for example with the cumulative all-cause mortality at 1-year in young patients being less than half what it is in non-young. Nonetheless this result isn't statistically significant, probably because the number of young patients wasn't enough.

In our study, young patients represented 8.4% and this proportion was stable during study period (8.3% in 2013, 8.5% in 2014, 8.3% in 2015). Tobacco smoking was the most prevalent risk factor in young patients, and is the only modifiable risk factor that is over-represented in young patients.

Ischemic heart disease frequency is increasing in number and represent the most common cause of death worldwide [1]. In Europe, incidence of AMI ranges from 90 to 312 and incidence of STEMI from 44 to 142 per 100000 per year [6]. In Switzerland, incidence of AMI was 183 per 100000 per year in 2014 and is increasing over time [7].
Short and long-term STEMI mortality in Europe is decreasing but remains important, with in-hospital mortality ranging from 4 to 12% and 1-year mortality being around 10% [1]. In our study, global in-hospital mortality was 5.2% whereas cumulative 1-year mortality was 11.2%.

Although the majority of STEMI occurs in older patients, non-negligent part of STEMI concerns young patients (≤45 years old). They usually represent 6-10% of STEMI patients [2,4,5,8,9] and this proportion seems to be increasing over time [2].

Only few studies have focused on the specific population of young patients treated by pPCI for STEMI [2-5] and no one concerned the specific population of Switzerland, and more specifically Vaud State.

Furthermore, the literature shows that it seems to be no consensus on age cut-off for the definition of young patients. Studies focusing on young patients with AMI generally use an age cut-off between 35 and 50 years old, among which many chose a limit of 45 years old to define young patients. We chose an age cut-off at 45 years old, since many previous studies have done the same thing [2-5,9-12], although a recent study of 3618 patients with STEMI treated by pPCI found that patients 45-60 years old have similar characteristic and mortality rate than those ≤45 years old and suggested an alteration of the “young” definition from ≤45 to <60 years old [2].

Some studies chose to focus on elderly patients, choosing an age cut-off at 75 [13-14], 80 [15], and 90 years old [16-17]. Such studies show a high mortality and high risk of complications in elderly patients.

Previous studies have shown that young patients who undergo pPCI for STEMI, when compared to their older peers, present a different risk factor profile; they are more likely to be men, to be active smokers, to have positive family history of premature coronary heart disease and are less likely to suffer from hypertension, dyslipidemia and diabetes [2-5]. Young patients are less likely to have AMI antecedent or reduced LVEF and more often present single-vessel disease [2-4].

The impact of classical cardiovascular risk factor such as smoking, hypertension, diabetes in AMI is well-known and can be found in old and young, males and females, and in all regions. [18]

Previous studies also showed that age is an important predictor of prognostic after an acute myocardial infarction [19]. Young patients have a lower rate of unsuccessful procedures [3], favorable in-hospital and intermediate term outcomes [3,11] and a reduced all-cause mortality rate [2,4].

One study of 28’778 patients with ACS in Switzerland found that patients ≤35 years old often present with STEMI but have favorable outcomes [20].

As stated by a recent study including 30’398 STEMI patients in Switzerland from 1997 to 2016, in-hospital mortality in those patients decreased from 9.8% to 5.5% in men and from 18.3% to 6.9% in women [21]. In our study, global in-hospital mortality was 5.2%.

A study of 1715 STEMI patients treated by PCI in the UK showed that tobacco smoking increases the risk of STEMI by 5 times and that the risk normalizes to a similar level as in never-smoker after smoking cessation [22]. A case-control study of 329 AMI in patients ≤45 years old in Portugal showed that a dose-effect response between tobacco smoking and AMI is present, with odds up to 8 times in patients smoking more than 25 cigarettes a day compared to never smokers, and with similar strength of association in both sexes [23]. Same study also found that the risk in former smokers was similar to never smokers. It has also been shown that quitting smoking is associated with an important reduction in mortality in CHD patients [24].
The role of tobacco smoking as a major risk factor for CAD being well-known, public health approaches targeting this risk factor could have a positive impact on STEMI in young patients [2]. For example, a few studies evaluated the impact of public smoking ban in certain parts of Switzerland [12,25] and found a significant impact on the number of AMI.

LIMITATIONS

The first and probably more important limitation was the number of patients included. Since we focused on a single center (which is the reference centre for Vaud State in Switzerland, which population is approx. 746K inhabitants), and only for a three-year period, we were limited by the number of patients, especially in the young group. Another limitation is the fact that the young group is almost exclusively composed of males. The small number of women, especially in the young group, doesn’t allow us to do gender comparison. This show the need for bigger studies with many more patients.

Another important limitation is the fact that the patients were only followed up to 12-month. It would have been interesting to have a long-term follow-up (3-5 years).

This study focused on the specific population of Vaud state in Switzerland which is mainly Caucasian. Due to ethnical differences and subsequent differences in risk factor profile, it is possible that the results we obtained could not be applicable to Asian or American populations.

CONCLUSION

In our study, young patients had a specific risk factor profile when opposed to their older peers. We couldn't find any significant difference in term of prognosis during hospital stay, and at 3- and 12-month follow-up.

Active smoking is the only modifiable risk factor that is over-represented in young patients. Therefore, we conclude on the utmost importance, as a matter of public health, of targeting smoking, especially in young individuals, to have an impact on STEMI in this population.

FUNDING

Cardiology, University Hospital Center (CHUV), Lausanne, Switzerland

CONFLICT OF INTEREST

The authors report no conflicts of interests.

REFERENCES

1. 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. 2017 Aug 26;

2. Rathod KS, Jones DA, Gallagher S, Rathod VS, Weerackody R, Jain AK, et al. Atypical risk factor profile and excellent long-term outcomes of young patients treated with primary percutaneous coronary intervention for ST-elevation myocardial infarction. Eur Heart J Acute Cardiovasc Care. 2015 Jan 14;

3. Ergelen M, Uyarel H, Gorgulu S, Norgaz T, Ayhan E, Akkaya E, et al. Comparison of outcomes in young versus nonyoung patients with ST elevation myocardial infarction treated by primary angioplasty. Coron Artery Dis. 2010 Mar;21(2):72–7.

4. Waziri H, Jørgensen E, Kelbæk H, Stagmo M, Pedersen F, Lagerqvist B, et al. Short and long-term survival after primary percutaneous coronary intervention in young patients with ST-elevation myocardial infarction. Int J Cardiol. 2016 Jan 15;203:697–701.

5. Reinstadler SJ, Eitel C, Thieme M, Metzler B, Poess J, Desch S, et al. Comparison of Characteristics of Patients aged ≤45 Years Versus >45 Years With ST-Elevation Myocardial Infarction (from the AIDA STEMI CMR Substudy). Am J Cardiol. 2016 May 1;117(9):1411–6.

6. Widimsky P, Wijns W, Fajadet J, de Belder M, 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 Apr;31(8):943–57.

7. Infarctus du myocarde | OBSAN [Internet]. [cited 2017 Dec 13]. Available from: https://www.obsan.admin.ch/fr/indicateurs/infarctus-du-myocarde

8. Choudhury L, Marsh JD. Myocardial infarction in young patients. The American Journal of Medicine. 1999 Sep;107(3):254–61.

9. Pineda J, Marín F, Roldán V, Valencia J, Marco P, Sogorb F. Premature myocardial infarction: clinical profile and angiographic findings. Int J Cardiol. 2008 May 7;126(1):127–9.

10. Egred M, Viswanathan G, Davis GK. Myocardial infarction in young adults. Postgrad Med J. 2005 Dec;81(962):741–5.

11. Chua S-K, Hung H-F, Shyu K-G, Cheng J-J, Chiu C-Z, Chang C-M, et al. Acute ST-elevation Myocardial Infarction in Young Patients: 15 Years of Experience in a Single Center. Clin Cardiol. 2010 Mar 1;33(3):140–8.

12. Di Valentino M, Muzzarelli S, Limoni C, Porretta AP, Rigoli A, Barazzoni F, et al. Reduction of ST-elevation myocardial infarction in Canton Ticino (Switzerland) after smoking bans in enclosed public places--No Smoke Pub Study. Eur J Public Health. 2015 Apr;25(2):195–9.

13. Dorobanţu M, Câlmâc L, Bogdan A, Bătăilă V, Drăgoescu B, Radu A, et al. Particularities in coronary revascularization in elderly patients presenting with ST segment elevation acute myocardial infarction (STEMI). Cor et Vasa. 2014 Aug;56(4):e342–7.

14. Fach A, Bünger S, Zabrocki R, Schmucker J, Conradi P, Garstka D, et al. Comparison of Outcomes of Patients With ST-Segment Elevation Myocardial Infarction Treated by Primary Percutaneous Coronary Intervention Analyzed by Age Groups (<75, 75 to 85, and >85 Years); (Results from the Bremen STEMI Registry). Am J Cardiol. 2015 Dec 15;116(12):1802–9.

15. Caretta G, Passamonti E, Pedroni PN, Fadin BM, Galeazzi GL, Pirelli S. Outcomes and predictors of mortality among octogenarians and older

with ST-segment elevation myocardial infarction treated with primary coronary angioplasty. Clin Cardiol. 2014 Sep;37(9):523–9.

16. Helft G, Georges J-L, Mouranche X, Loyeau A, Spaulding C, Caussin C, et al. Outcomes of primary percutaneous coronary interventions in nonagenarians with acute myocardial infarction. Int J Cardiol. 2015 Aug 1;192:24–9.

17. Mizuguchi Y, Hashimoto S, Yamada T, Taniguchi N, Nakajima S, Hata T, et al. Percutaneous coronary intervention for nonagenarian patients with ST-segment elevation myocardial infarction: Experience of a single Japanese center. J Cardiol. 2016 Apr;67(4):331–4.

18. Yusuf S, Hawken S, Ounpuu S, Dans T, Avezum A, Lanas F, et al. Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): case-control study. Lancet. 2004 Sep 11;364(9438):937–52.

19. Dziewierz A, Siudak Z, Rakowski T, Dubiel JS, Dudek D. Age-related differences in treatment strategies and clinical outcomes in unselected cohort of patients with ST-segment elevation myocardial infarction transferred for primary angioplasty. J Thromb Thrombolysis. 2012 Aug;34(2):214–21.

20. Schoenenberger AW, Radovanovic D, Stauffer J-C, Windecker S, Urban P, Niedermaier G, et al. Acute coronary syndromes in young patients: presentation, treatment and outcome. Int J Cardiol. 2011 May 5;148(3):300–4.

21. Radovanovic D, Seifert B, Roffi M, Urban P, Rickli H, Pedrazzini G, et al. Gender differences in the decrease of in-hospital mortality in patients with acute myocardial infarction during the last 20 years in Switzerland. Open Heart. 2017 Nov 1;4(2):e000689.

22. Steele L, Lloyd A, Fotheringham J, Sultan A, Iqbal J, Grech ED. A retrospective cross-sectional study on the association between tobacco smoking and incidence of ST-segment elevation myocardial infarction and cardiovascular risk factors. Postgrad Med J. 2015 Sep;91(1079):492–6.

23. Oliveira A, Barros H, Maciel MJ, Lopes C. Tobacco smoking and acute myocardial infarction in young adults: a population-based case-control study. Prev Med. 2007 Apr;44(4):311–6.

24. Critchley JA, Capewell S. Mortality risk reduction associated with smoking cessation in patients with coronary heart disease: a systematic review. JAMA. 2003 Jul 2;290(1):86–97.

25. Bonetti PO, Trachsel LD, Kuhn MU, Schulzki T, Erne P, Radovanovic D, et al. Incidence of acute myocardial infarction after implementation of a public smoking ban in Graubünden, Switzerland: two year follow-up. Swiss Med Wkly. 2011 May 27;141:w13206.

FIGURES AND TABLES

Table 1 – Clinical characteristics:

	young	old	p-value
>basic characteristics			
age (n=753)	39.90 ± 5.18	66.08 ±11.94	**<0.001**
males (n=752)	59 (95.2%)	506 (73.3%)	**<0.001**
bmi (n=753)	28.08 ±5.83	26.68 ± 4.25	0.067
>history			
angina (n=742)	1 (1.6%)	77 (11.3%)	**0.017**
MI (n=745)	4 (6.3%)	104 (15.2%)	0.055
CABG (n=751)	0 (0.0%)	22 (3.2%)	0.150
PCI (n=749)	4 (6.3%)	107 (15.6%)	**0.048**
>risk factors			
active smoking (n=551)	45 (78.9%)	254 (51.4%)	**<0.001**
hypertension (n=687)	11 (17.7%)	363 (52.8%)	**<0.001**
diabetes (n=683)	7 (11.1%)	130 (19.0%)	0.120
dyslipidemia (n=672)	45 (77.6%)	485 (72.2%)	0.375
family history (n=570)	29 (49.2%)	177 (31.1%)	**0.005**
overweight (n=753)	24 (38.1%)	288 (41.7%)	0.574
obesity (n=753)	16 (25.4%)	132 (19.1%)	0.231
alcohol (n=595)	16 (35.6%)	190 (34.5%)	0.891
alcohol >2units/d (n=594)	7 (15.6%)	82 (14.9%)	0.911
cocaine (n=619)	1 (2.3%)	3 (0.5%)	0.162
anabolics (n=619)	1 (2.3%)	4 (0.7%)	0.260
>findings			
anterior localization (n=730)	27 (45.0%)	298 (44.5%)	0.938
lateral localization (n=730)	9 (15.0%)	108 (16.1%)	0.821
inferior localization (n=730)	28 (46.7%)	341 (50.9%)	0.530
posterior localization (n=730)	6 (10.0%)	78 (11.6%)	0.703
LVEF >40% (n=575)	37 (82.2%)	393 (74.2%)	0.231
LVEF 30-40% (n=575)	6 (13.3%)	100 (18.9%)	0.358
LVEF <30% (n=575)	2 (4.4%)	37 (7.0%)	0.516
>procedural characteristics			
single-vessel disease (n=753)	40 (63.5%)	290 (42.0%)	**0.001**
2-vessel disease (n=753)	14 (22.2%)	223 (32.3%)	0.099
3-vessel disease (n=753)	7 (11.1%)	175 (25.4%)	**0.011**

MI = myocardial infarction, CABG = coronary artery bypass grafting, PCI = percutaneous coronary intervention, Active smoking: active smokers were compared to never smokers (former smokers were ignored for this analysis), Family history: defined as coronary heart disease in a first-degree parent before 60 years old, overweight: defined as BMI 25-29.9, obese: defined as BMI ≥ 30, localization: as visualized on the ECG, LVEF = left ventricular ejection fraction

Table 2 – Short-term outcomes:

	young	old	p-value
procedural complications			
no-reflow / slow-flow (n=753)	4 (6.3%)	47 (6.8%)	0.889
other coronary artery occlusion (n=753)	1 (1.6%)	26 (3.8%)	0.373
coronary perforation (n=753)	1 (1.6%)	2 (0.3%)	0.118
infarction (n=753)	1 (1.6%)	5 (0.7%)	0.461
emergency CABG (n=752)	0 (0.0%)	6 (0.9%)	0.457
pericardial drainage (n=753)	1 (1.6%)	1 (0.1%)	**0.033**
rhythm disorders (n=753)	9 (14.3%)	79 (11.4%)	0.502
death (n=753)	0 (0.0%)	3 (0.4%)	0.600
hospital stay complications			
ICU stay (n=753)	15 (23.8%)	221 (32.0)	0.178
stay in continuing care (n=753)	57 (90.5%)	585 (84.8%)	0.222
AV block (n=750)	2 (3.2%)	29 (4.2%)	0.690
cardiogenic shock (n=750)	5 (7.9%)	45 (6.6%)	0.673
ischemia (n=749)	0 (0.0%)	8 (1.2%)	0.389
new myocardial infarction (n=749)	0 (0.0%)	10 (1.5%)	0.335
stroke (n=750)	1 (1.6%)	12 (1.7%)	0.926
renal failure (n=749)	4 (6.5%)	55 (8.0%)	0.664
hemorrhage BARC≥2 (n=748)	4 (6.3%)	37 (5.4%)	0.752
short-term prognostic			
hospital survival (n=753)	61 (96.8%)	653 (94.6%)	0.453
hospital death (n=753)	2 (3.2%)	37 (5.4%)	0.453
>age at death (n=39)	28.50 ± 17.68	72.76 ± 10.83	**<0.001**
>hospital stay length at death (n=39)	15.00 ± 15.56	9.81 ± 30.76	0.723
death of cardiovascular cause (n=753)	0 (0.0%)	14 (2.0%)	0.254
death of mechanical cause (n=753)	1 (1.6%)	5 (0.7%)	0.461
death by arrhythmia (n=753)	1 (1.6%)	3 (0.4%)	0.228
death by sepsis (n=753)	1 (1.6%)	15 (2.2%)	0.757
death by hemorrhage(n=753)	1 (1.6%)	2 (0.3%)	0.118
death by anoxic encephalopathy (n=753)	2 (3.2%)	7 (1.0%)	0.131
death of non-cardiac cause (n=753)	0 (0.0%)	2 (0.3%)	0.669
death of other cause (n=753)	1 (1.6%)	5 (0.7%)	0.461
length of stay at hospital (n= 712)	5.61 ± 8.27	6.29 ± 13.66	0.700

length of stay at hospital: doesn't include patients that died during hospital stay

Table 3 – Medium-term outcomes:

	young	old	p-value
3-month follow up			
death of all causes (n=391)	0 (0.0%)	6 (1.6%)	0.510
death of cardiovascular cause (n=391)	0 (0.0%)	4 (1.1%)	0.592
myocardial infarction (n=391)	0 (0.0%)	6 (1.6%)	0.510
stroke (n=390)	0 (0.0%)	1 (0.3%)	0.789
new revascularization of lesion needed (n=390)	0 (0.0%)	9 (2.5%)	0.417
intrastent thrombosis (n=390)	0 (0.0%)	1 (0.3%)	0.789
hemorrhage BARC≥2 (n=385)	2 (7.7%)	13 (3.6%)	0.300
hospitalization for cardiovascular cause (n=85)	1 (20.0%)	11 (13.8%)	0.697
12-month follow up			
death of all causes (n=483)	0 (0.0%)	14 (3.2%)	0.254
death of cardiovascular cause (n=480)	0 (0.0%)	7 (1.6%)	0.422
myocardial infarction (n=475)	0 (0.0%)	7 (1.6%)	0.419
stroke (n=474)	0 (0.0%)	4 (0.9%)	0.542
lesion revascularization (n=476)	1 (2.5%)	11 (2.5%)	0.993
intrastent thrombosis (n=476)	0 (0.0%)	5 (1.1%)	0.496
hemorrhage BARC≥2 (n=475)	1 (2.5%)	27 (6.2%)	0.341
hospitalization for cardiovascular cause (n=282)	3 (12.5%)	41 (15.9%)	0.661

Table 4 – Deaths

	total	young	old	p-value
all-cause				
in-hospital (n=753)	39 (5.2%)	2 (3.2%)	37 (5.4%)	0.453
3-month follow-up (n=391)	6 (1.5%)	0 (0.0%)	6 (1.6%)	0.510
12-month follow-up (n=483)	14 (2.9%)	0 (0.0%)	14 (3.2%)	0.254
cumulative deaths at 1-year (n=528)	59 (11.2%)	2 (4.8%)	57 (11.7%)	0.169
cardiovascular cause				
in-hospital (n=753)	14 (1.9%)	0 (0.0%)	14 (2.0%)	0.254
3-month follow-up (n=391)	4 (1.0%)	0 (0.0%)	4 (1.1%)	0.592
12-month follow-up (n=480)	7 (1.5%)	0 (0.0%)	7 (1.6%)	0.422
cumulative deaths at 1-year (n=498)	25 (5.0%)	0 (0.0%)	25 (5.5%)	0.129

Table 5 – Treatments:

	total	young	old	p-value
when leaving hospital				
DAPT (n=712)	707 (99.3%)	60 (98.4%)	647 (99.4%)	0.359
Beta blocker (n=695)	538 (77.4%)	51 (85.0%)	487 (76.7%)	0.141
ACEI / ARB (n=709)	632 (89.1%)	59 (96.7%)	573 (88.4%)	**0.047**
statin (n=676)	674 (99.7%)	58 (100%)	616 (99.7%)	0.664
3-month follow up				
DAPT (n=385)	351 (91.2%)	25 (96.2%)	326 (90.8%)	0.354
Beta blocker (n=385)	313 (81.3%)	23 (88.5%)	290 (80.8%)	0.332
ACEI / ARB (n=385)	326 (84.7%)	24 (92.3%)	302 (84.1%)	0.263
statin (n=383)	383 (94.5%)	25 (96.2%)	337 (94.4%)	0.704
12-month follow up				
DAPT (n=471)	223 (47.3%)	17 (42.5%)	206 (47.8%)	0.521
Beta blocker (n=471)	366 (77.7%)	35 (87.5%)	331 (76.8%)	0.120
ACEI / ARB (n=468)	383 (81.8%)	34 (85.0%)	349 (81.5%)	0.587
statin (n=471)	426 (90.4%)	36 (90.0%)	390 (90.5%)	0.920

DAPT = Dual Antiplatelet Therapy, ACEI = angiotensin-converting-enzyme inhibitor, ARB = Angiotensin II receptor blocker

Table 6 – Secondary Prevention:

	total	young	old	p-value
3-month				
weight control (n=376)	186 (49.5%)	15 (57.7%)	171 (48.9%)	0.385
physical activity (n=368)	275 (74.7%)	18 (75.0%)	257 (74.7%)	0.975
smoking cessation (n=152)	86 (56.7%)	14 (73.7%)	72 (54.1%)	0.108
blood pressure control (n=380)	326 (85.8%)	22 (88.0%)	304 (85.6%)	0.743
lipid profile control (n=215)	150 (69.8%)	10 (83.3%)	140 (69.0%)	0.292
glycemic control (n=74)	36 (48.6%)	1 (33.3%)	35 (49.3%)	0.588
12-month				
weight control (n=440)	238 (54.1%)	22 (55.0%)	216 (54.0%)	0.904
physical activity (n=429)	285 (66.4%)	26 (66.7%)	259 (66.4%)	0.974
smoking cessation (n=171)	83 (48.5%)	16 (59.3%)	67 (46.5%)	0.224
blood pressure control (n=454)	441 (97.1%)	40 (100%)	401 (96.9%)	0.255
lipid profile control (n=387)	334 (86.3%)	28 (84.8%)	306 (86.4%)	0.799
glycemic control (n=80)	63 (78.8%)	2 (66.7%)	61 (79.2%)	0.602

weight control: BMI 18.5-24.9 or significant weight loss, physical activity: ≥30min, 3-4x/week, blood pressure control: BP ≤140 mmHg or ≤ 130mmHg if diabetic, lipid profile control: LDL-cholesterol ≤1.8 mmol/l, glycemic control: HbA1c < 7%, only concerns diabetic patients

Figure 1 – Age repartition

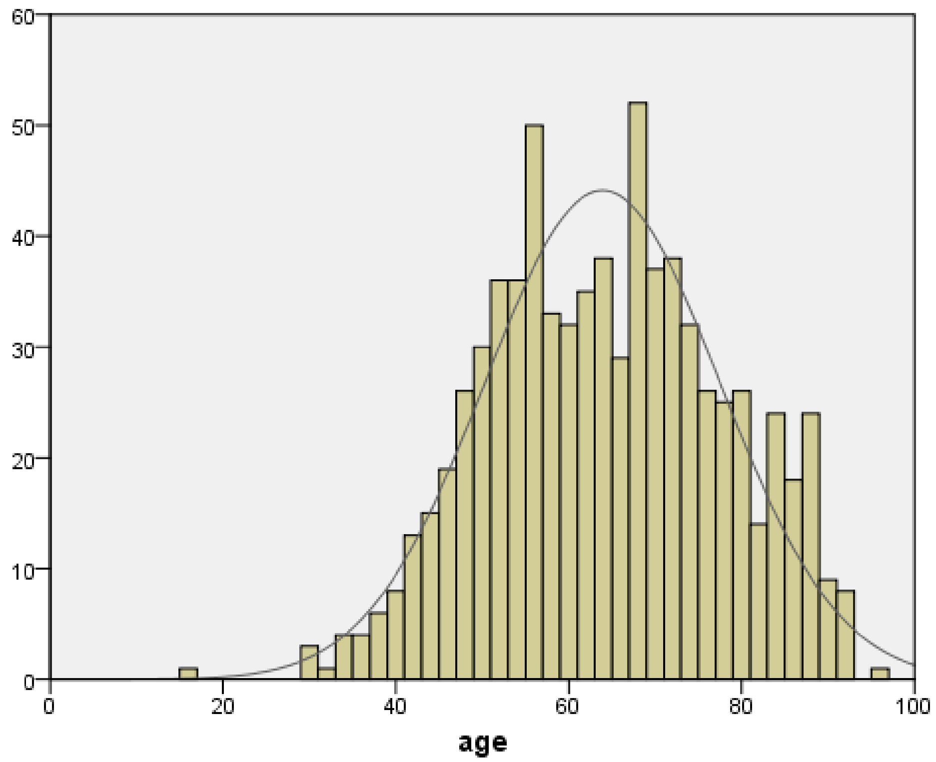


Figure 2 – Age groups

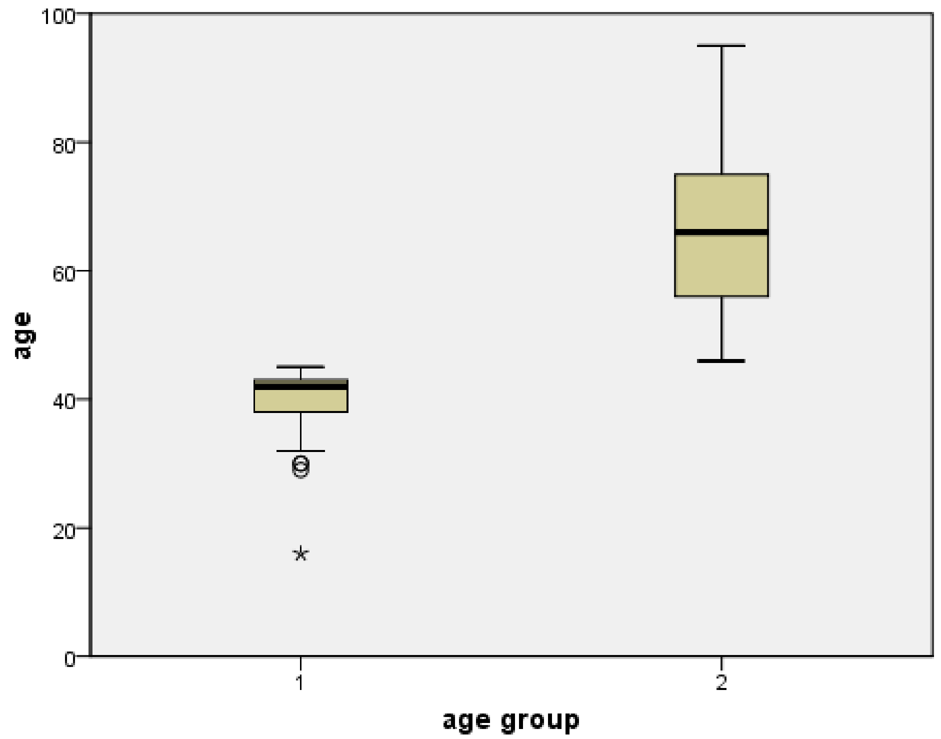


Figure 3 – History

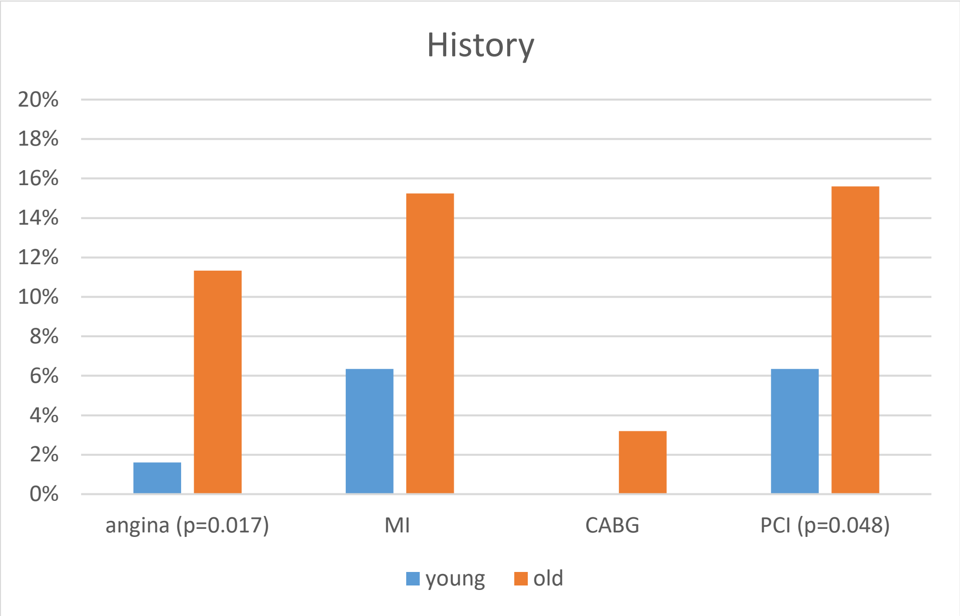
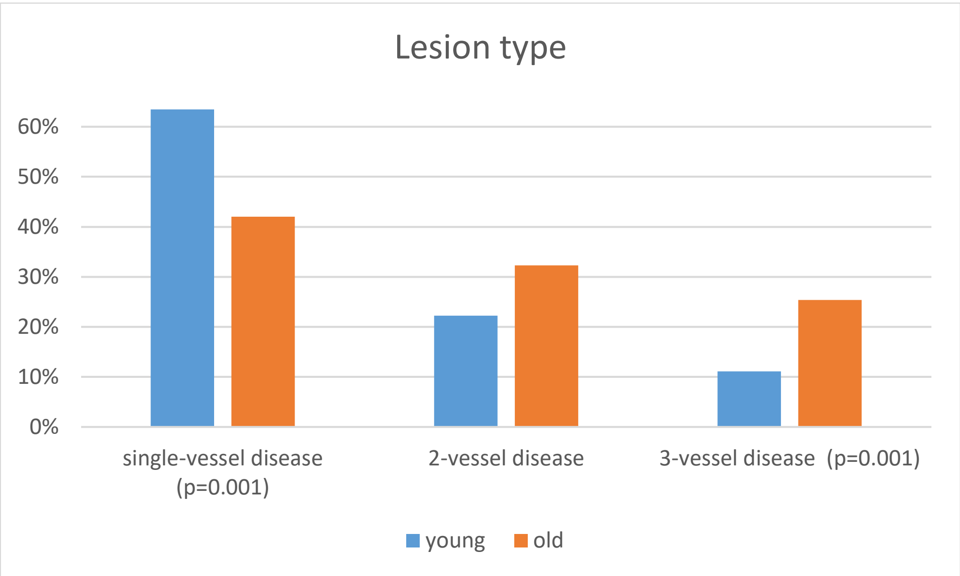
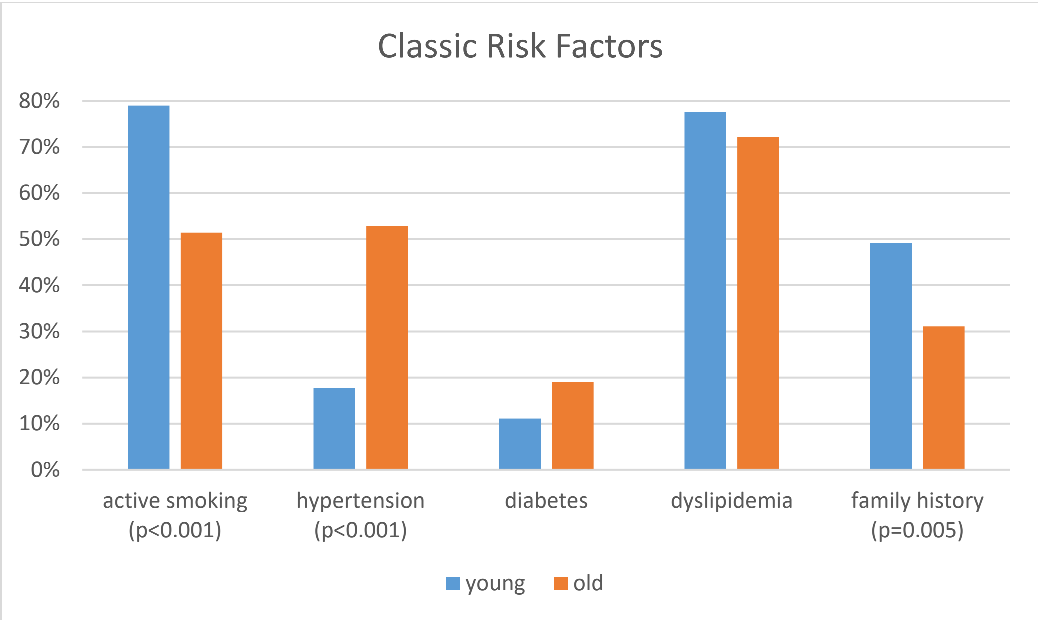


Figure 4 – Lesion type



Figures 5 and 6 - Risk Factors



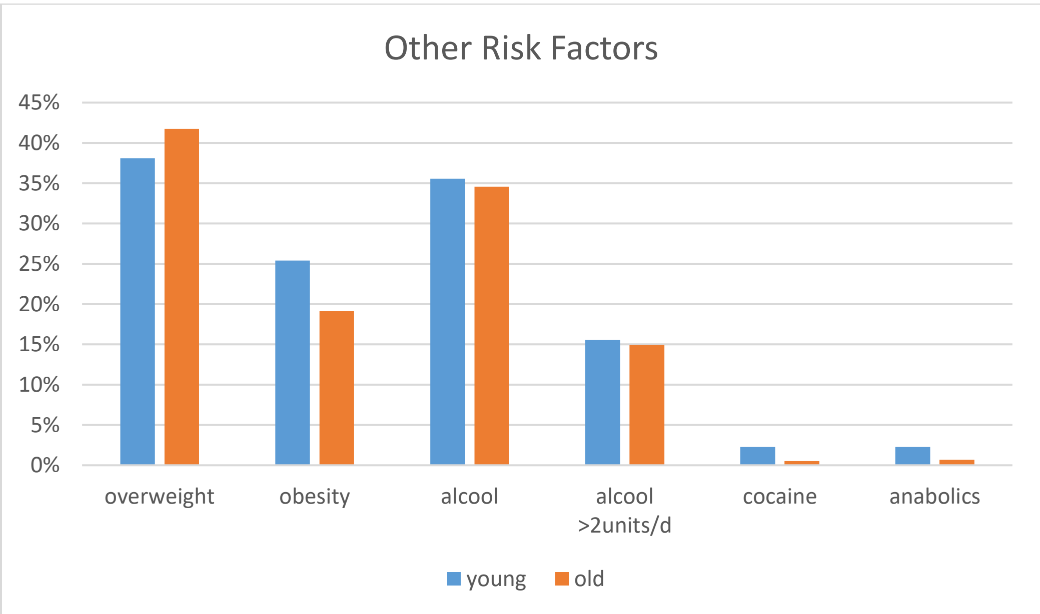
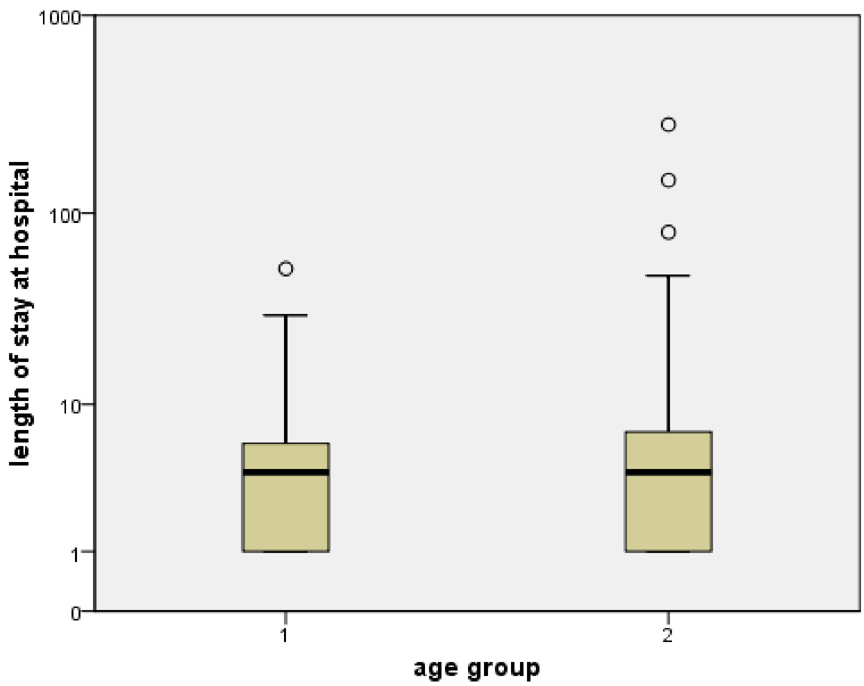
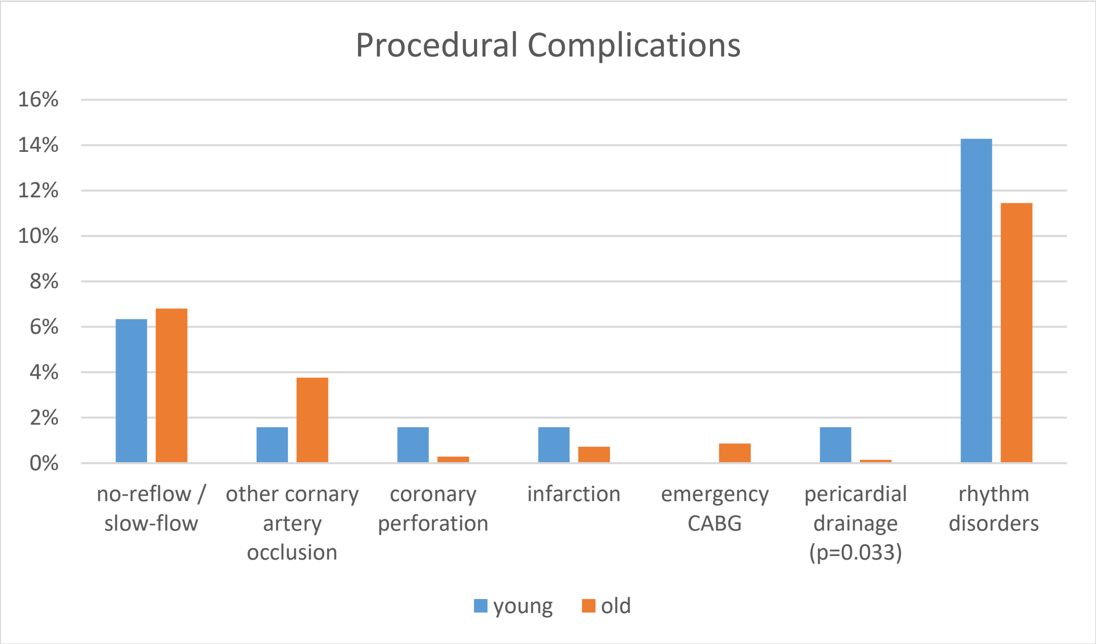


Figure 7 – Hospital stay length



Figures 8 and 9 – Short-term outcomes



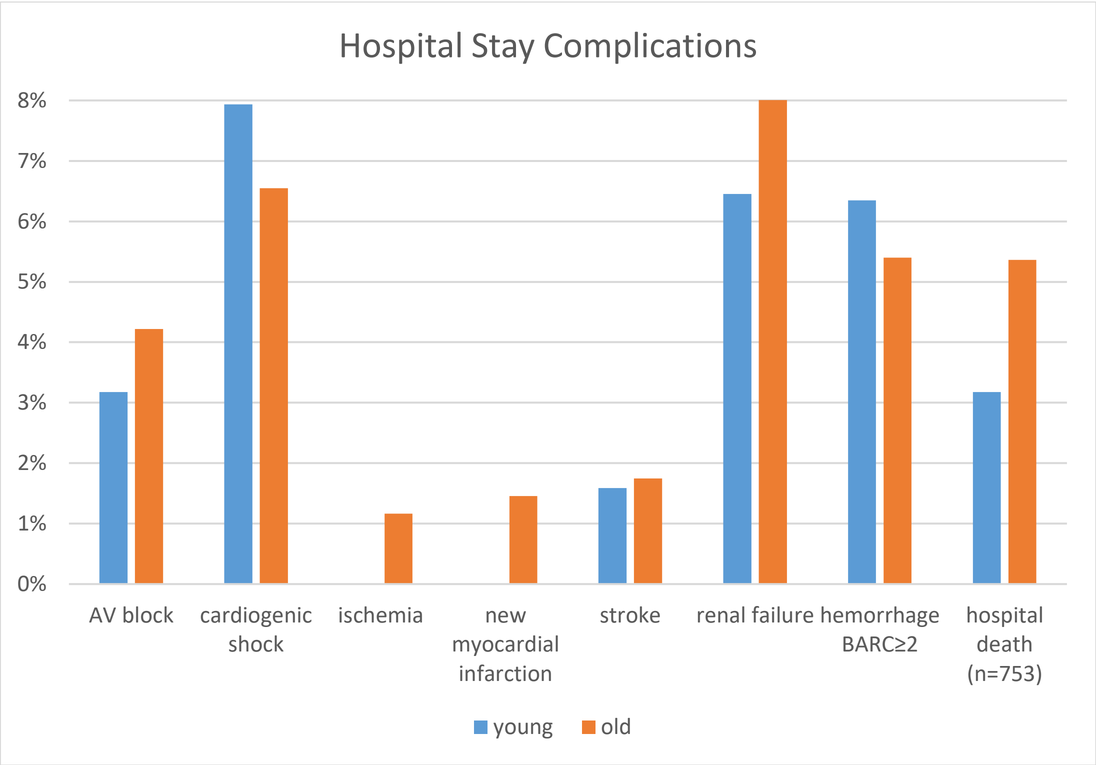


Figure 10 – Medium-term outcomes

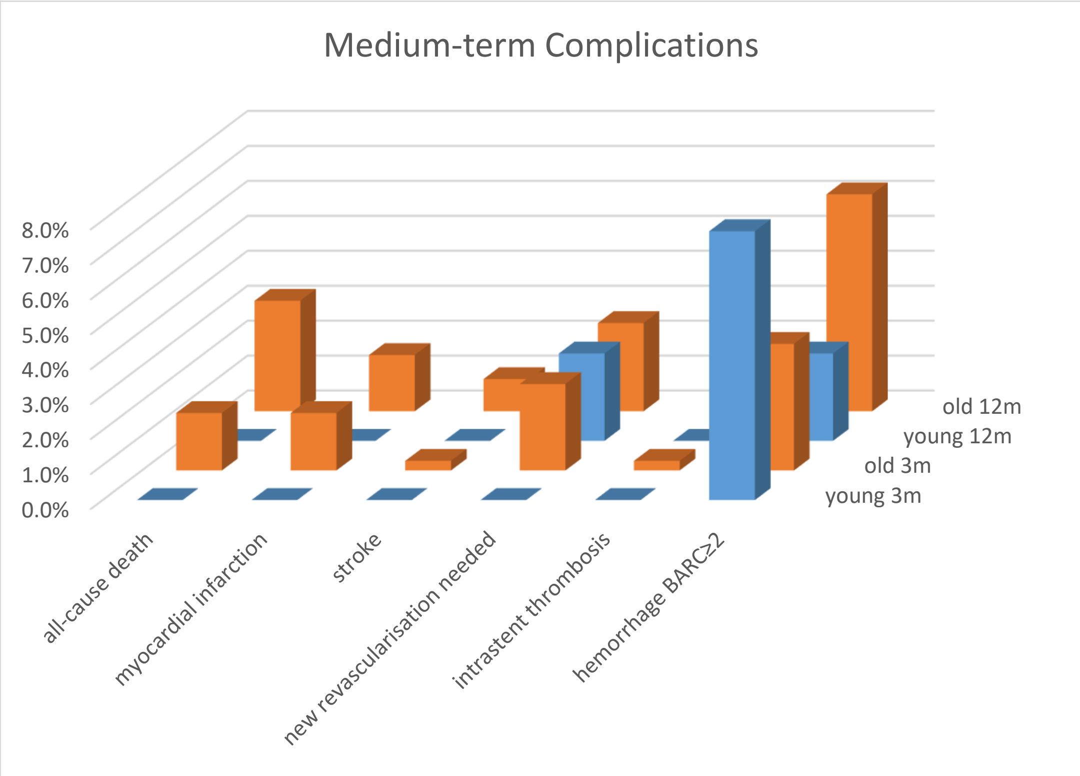
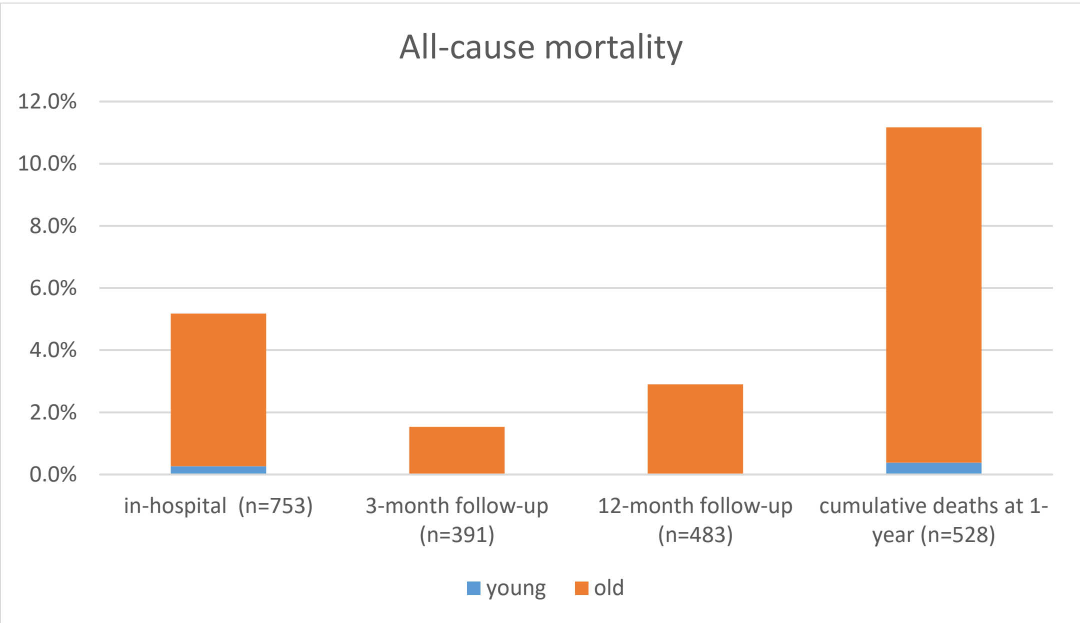
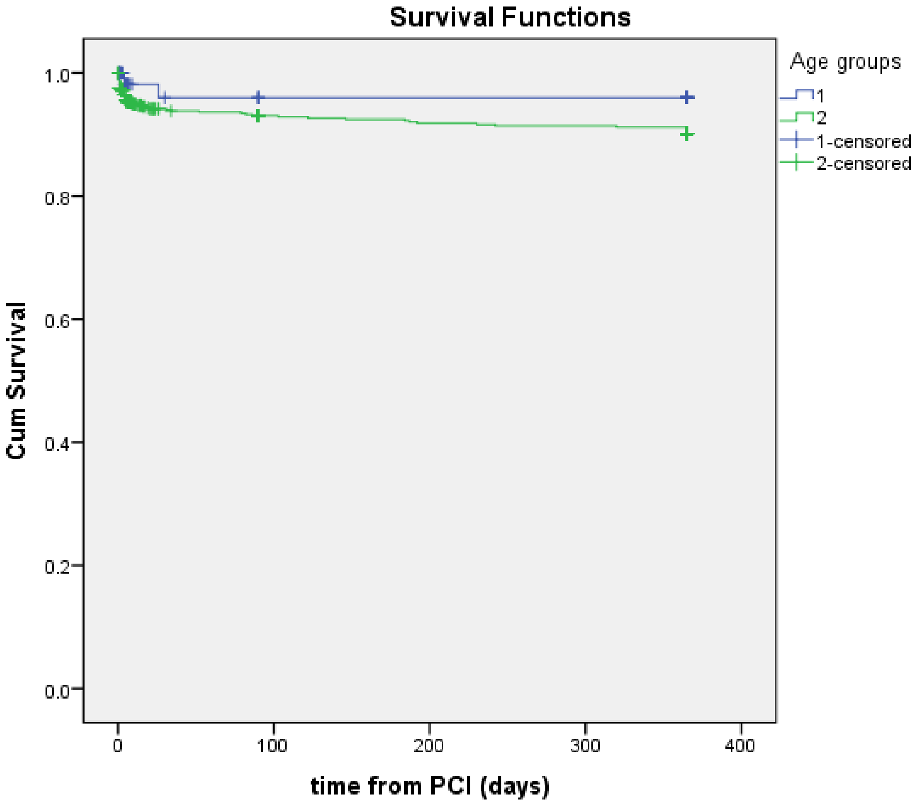
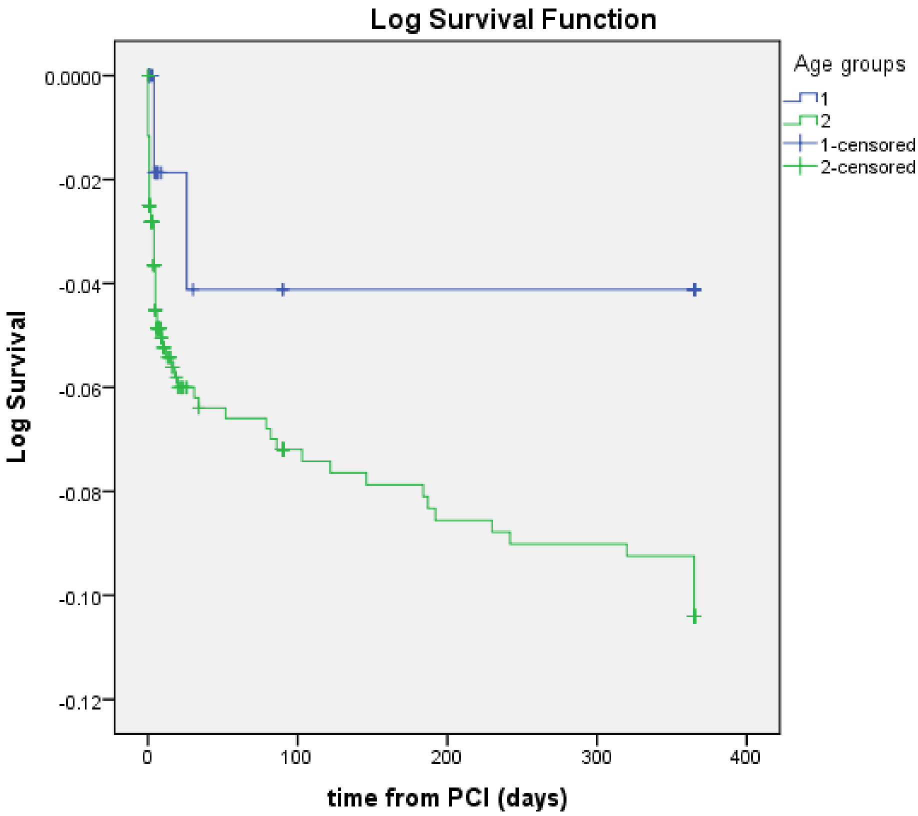


Figure 11 to 13 – Deaths and Survival





Survival Functions
Age groups
1
2
1-censored
2-censored
Cum Survival
1.0
0.8
0.6
0.4
0.2
0.0
0
100
200
300
400
time from PCI (days)



Log Survival Function
Age groups
1
2
1-censored
2-censored
Log Survival
0.0000
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
0
100
200
300
400
time from PCI (days)

Figure 14 and 15 – Treatments