Rationing during the Covid-19 Pandemic:

Effects on the Probability of Death among In-Hospital Patients Receiving Angioplasty

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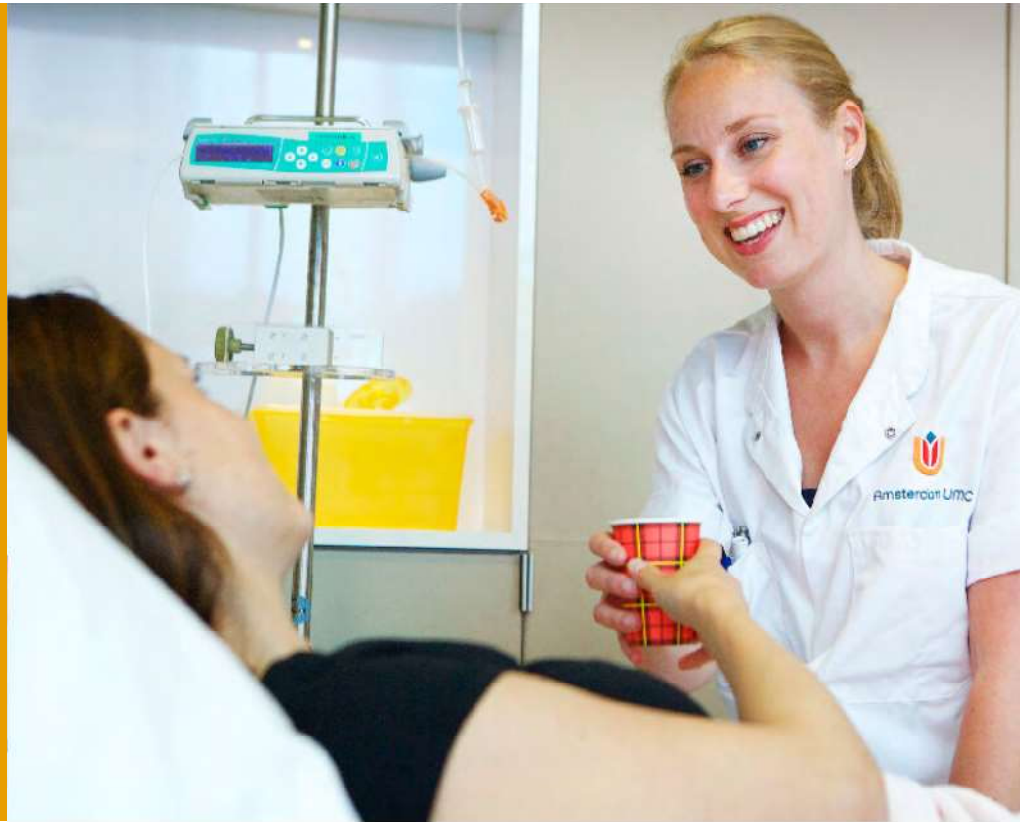
Take Aways

- Results suggest that a significant proportion of excess mortality in 2021 **(2153 deaths)** can be contributed to the **“rationing” effect in hospitals during Covid-19** in patients who needed an acute or non-acute angioplasty (dotter) in 2020 or 2021.
- The otherwise downward trend for cardiac-related mortality is offset by rationing effect / deferred care during Covid-19 pandemic
- The effect of rationing on death was disproportionally high among cardiac patients who needed **acute angioplasty** (dotter)
  - This includes acute and subacute diagnoses

Deferred Care

- Timely diagnosis and treatment is critical to improve outcomes for cardiac conditions
  - Angina Pectoris followed by non-acute angioplasty versus myocardial infarction followed by acute angioplasty (STEMI and non-STEMI)
- Effects of delayed, deferred and cancelled care on health outcomes and mortality are well understood
- Before Covid-19 pandemic, studies focused on longer wait times for access to care
- Prehospital delays vs. deferred procedures
  - **<u>Lack of access to primary care data (VEKTIS) to study this</u>**



Rationing

- Definition: “Controlled distribution of scarce healthcare resources or an artificial restriction of demand according to some distribution principle”
- Decisions need to be made regarding efficient distribution of resources
  - Denying patients potentially beneficial healthcare services as a result of scarcity
  - Dealing with distributive justice/equity and optimizing health outcomes for entire population
- During pandemic shift from utilitarian framework of rationing to “rule of rescue”
  - Effect on **Triage practices**

Covid-19 effect on Cardiological Care Chain

Trends in other countries show large share of excess mortality in 2020 and 2021 was caused by hypertension and heart disease

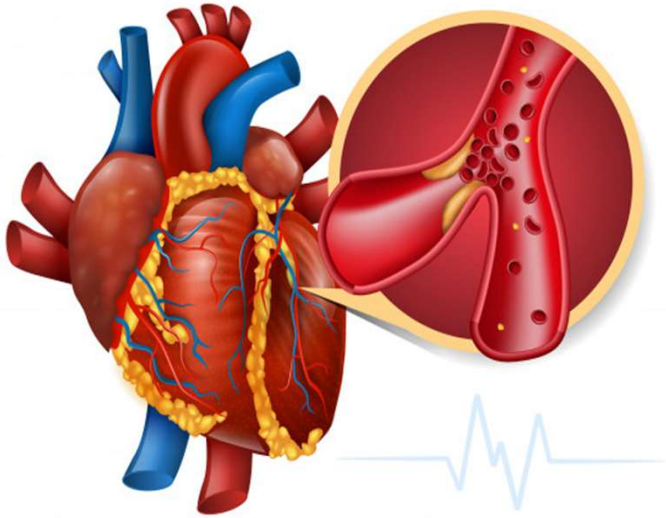
- In The Netherlands, Dutch Association for Cardiology (NVVZ) published report concluding that pandemic had **significant impact on entire cardiological care chain**
  - **Pre-hospital care unclear**
- Special issue on Covid-19 in The Netherlands Heart Journal also highlighted **negative impact on mortality and morbidity**, but need to quantify
- Effects on mortality are especially visible in **access to critical care**

Objective

To determine the effect of rationing in 2020 on death and length of stay (LOS) among in-hospital patients needing angiopl

Hypotheses:

- *Rationing (Triage practices) during the pandemic have led to a significant increase in the probability of death among cardiac patients who needed angioplasty and contributed to excess mortality in 2021*
- *Effect will be proportionally higher among patients with comorbidities, immigrants and those with lower socio-economic status*



Mixed Methods

- **Qualitative Interviews**
  - Performed between July 2023 and January 2024
  - Structured Interviews to identify major themes, text data analyzed with Nvivo 14
- **Quantitative Analytic Approach**
  - Dependent variable: probability of death
  - Main independent variable: difference-in-differences (DiD) estimator
    - Used to assess causal effect
    - Interaction model: time*treatment = 2020-2021*acute angioplasty
      - Tests whether the expected mean change in probability of death before and during Covid-19 pandemic was different for patients receiving (sub)acute angioplasty versus non-acute (difference in rate change)
    - Logic behind DID (quasi-experimental design) is that if event never happens, differences between treatment and control groups should stay same overtime
- Random Effects Logit model to estimate effect of Rationing on Probability of Death
- Regression equation, general form:

$$y=\beta_0+\beta_1 time+\beta_2 treated+\beta_3 time*treated+\beta_4 covariates+\varepsilon$$

Qualitative Interviews

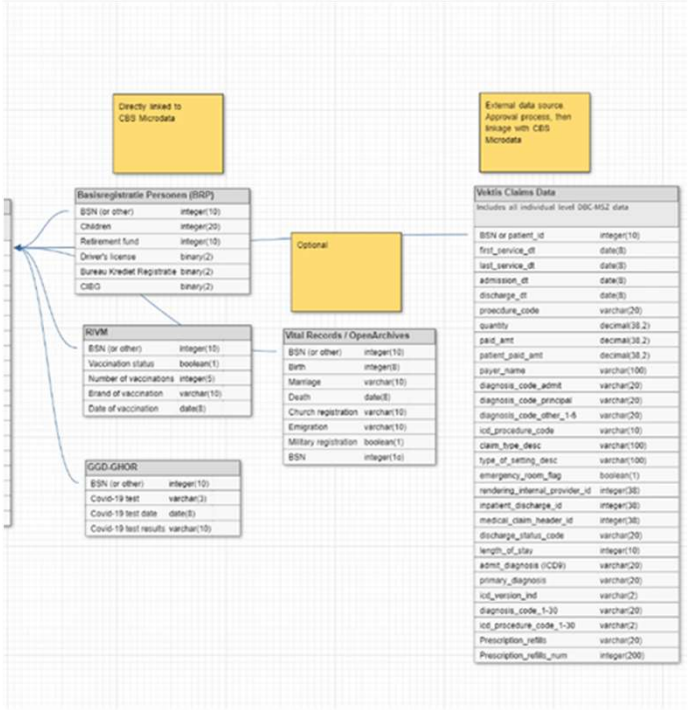
- Hospital capacity concerns affected entire cardiological care chain
- Triage practices shifted but unclear when and in what direction
- Unclear whether this was consistent policy or “ad hoc” decision-making
- ICU physicians expect larger rationing effect on mortality in acute care patients (ICU vs coronary care unit CCO)
- All interviewees expect significant cardiac contribution to excess mortality rates
- Dutch Hospital Data to get lab results for clinical detail on entire care path

Data (n=112,651)

131,293 people in 2018 – 2021;
- Excluded patients who had both – for subsequent Time to Treat analysis
- Excluded patients with missing values for seswoa, region and urbanness

56,238 non-acute (49.9%)
56,413 acute (50.1%)

- Years 2018-2021 (4 years of data)
- **After**: March-Dec 2020 & 2021
- **Treated**: Percutaneous Transluminal Coronary Angioplasty (PTCA, "dotteren")
  - **Acute PTCA** (based on diagnosis codes): Vektis code 033238
  - **Non-acute PTCA** (""): Vektis care codes 033231 - 033235
- **Comorbidities**: Prescription dispensing claims were used to calculate the Rx-Risk Index
- **Immigration status** - Born abroad, or at least 1 parent
- **SESWOA welvaart**
- **SESWOA opleiding**
- **SESWOA recent arbeidsverleden**
- **15 Regions** based on zip code
- **Urbanness level** (1-5)
- **Covid positive test**: 2 weeks prior, 12 weeks prior, ever before
- **Covid vaccination status**
- **Time trend**



Descriptive Statistics

Study population, overall descriptive statistics

	Study population	Netherlands (2023)
Percentage male	71%	50%
Mean age	69	42
Mean Rx-Risk Comorbidity Index	6.9	? (but much lower)
Percentage born abroad	12%	16%
Percentage at least one parent born abroad	18%	26%
Mean SES income & assets	0.04	0
Mean SES education	-0.05	0
Mean SES recent labor history	-0.03	0

Descriptive Statistics

Time To Treat (TTT). Time from **FIRST** relevant diagnosis.

	Period 1	Period 2	Period 3
Acute: median time (days)	0	0	1
Acute: mean time (days)	74	147	223
Acute: % longer than 30 days	21%	25%	29%
Non-acute: median time (days)	76	111	127
Non-acute: mean time (days)	163	297	413
Non-acute: % longer than 30 days	67%	71%	74%

Results: DiD Base Model

N=12,651	Marginal effect (SE)	p-value
After	**0.0254 (0.0050)**	**P<.001**
Treated	**0.0307 (0.0023)**	**P<.001**
DiD / rate change	**0.0339 (0.0040)**	**P<.001**
Female	-0.0264 (0.0021)	P<.001
Age	0.0075 (0.0001)	P<.001
Rx Risk score	0.0078 (0.0078)	P<.001
Born abroad	-0.0158 (0.0045)	P<.001
At least 1 parent “”	0.0088 (0.0037)	P=.019
SES Deelscore welvaart	-0.0529 (0.0033)	P<.001
SES “” Opleidingsniveau	-0.0126 (0.0034)	P<.001
SES “” Recent Arbeidsverleden	-0.0302 (0.0042)	P<.001
Covid pos test ever before	**0.0288 (0.0090)**	**P<.001**
Covid vaccination	**-0.0016 (0.0042)**	**P=.698**
Time	-0.0694 (0.0026)	P<.001

	Marginal effect (SE)	p-value
REGION (1-15)		
1 Zuid Holland		
6 Noord-Brabant	0.0086 (0.0035)	P=.014
7 Limburg	0.0133 (0.0040)	P<.001
8 Gelderland	0.0098 (0.0040)	P=.014
11 Gebied bij Ijsselmeer	0.0146 (0.0057)	P=.011
URBANNESS LEVEL		
1 Zeer sterk stedelijk		
2 Sterk stedelijk	-0.0031 (0.0033)	P=.349
3 matig	-0.0062 (0.0037)	P=.094
4 Weinig	-0.0110 (0.0036)	P=.002
5 Niet	-0.0073 (0.0031)	P=.018

Results: DiD Interaction Models

- **Large interaction effect for SES and Covid infection:** those with lower SES score and with covid infection in past 2 weeks have 37.3% higher probability of dying
- Interaction Covid * Region: those with covid in **Drenthe** more likely to die
- Those in **“zeer stedelijke” urbanness-level** with Covid more likely to die
- No interaction effect between Covid-19 infection (2w, 12w, ever) and acute care patients or Covid-19 vaccination
- No interaction effect for immigration status and Covid-19.

Conclusions

	2020	2021	TOTAAL
Acute	686	879	1,565
Non-Acute	263	325	588
TOTAAL	949	1,204	2,153

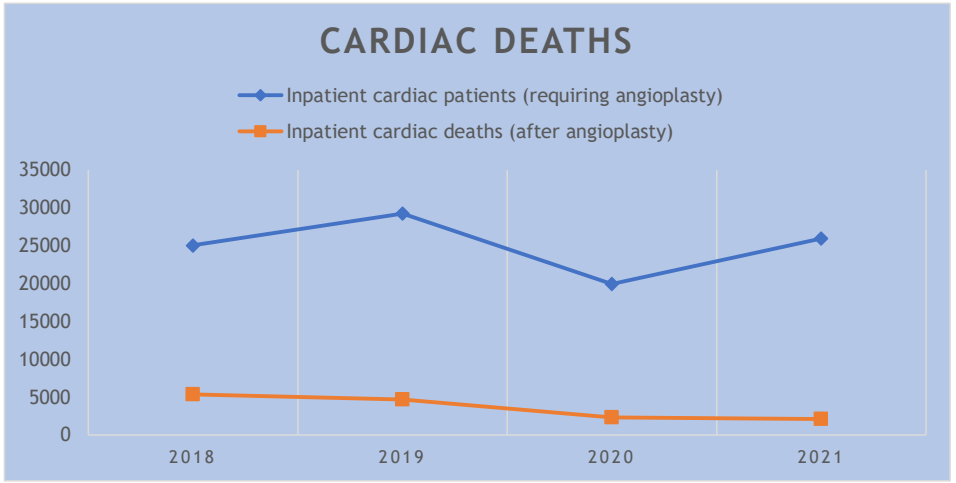
- In-hospital patients needing acute angioplasty during Covid-years had **higher probability of dying**
  - Overall, probability of death is 2.5 percentage points higher during Covid-years
  - For patients who needed the acute angioplasty, this is 3.1 percentage points higher than those who needed non-acute
  - During Covid years 2020-2021, acute patients had a 3.4 percentage point further increase relative to non-acute
- All covariates (but some regions) had very small p-values (<0.001) and the expected signs
- Model results were robust to several sensitivity checks and statistical tests
  - Parallel Trends assumptions holds
  - Chi square tests and tests showed no significant differences between groups
- Covid-19 and Vaccination had no significant effect on probability of death among cardiac patients who had PCI (percutanuous coronary interventions)

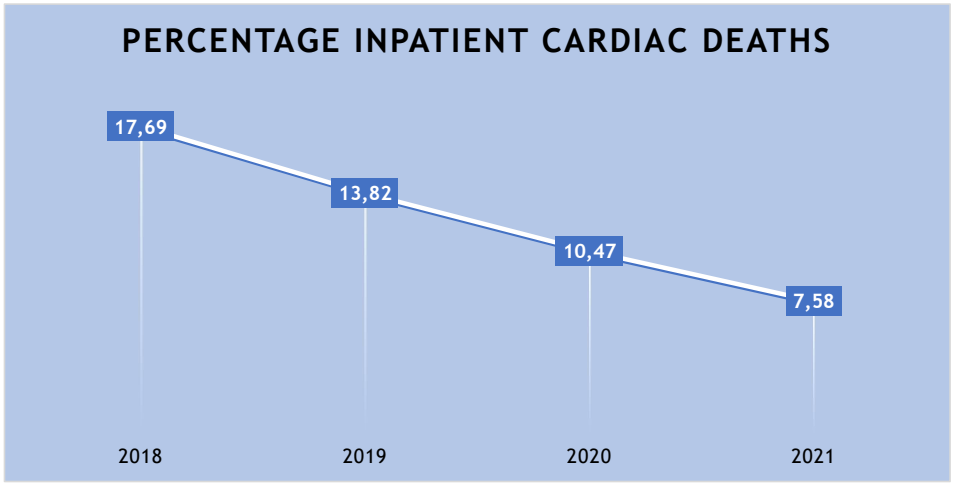
Discussion

- Cardiologists worked during challenging times and rationing was targeted at optimizing health outcomes for the majority of the patient population
  - Results suggest that angioplasty was delayed / avoided in patients with elevated troponin levels
- **Downward trend death rate in cardiac patients offset by rationing effect during Covid-19 pandemic**
  - Implications for evaluation of decision-making during Covid-19: did rationing / inpatient decision-making indeed optimize health outcomes for entire population?
  - Lessons learned for pandemic preparedness?
- **Need for extension with 2022 data** (and 2023) to better understand the Covid / Rationing effect on mortality among cardiac patients who need inpatient angioplasty
  - Linear trend?
- **Need for extension of study focused on other inpatient service lines**: cancer care, elective surgery, et cetera
- **Next steps**: zero-truncated negative binomial models to estimate length of stay (LOS) and time to treat analysis
- Challenges with access to data and data accuracy remain
  - Eerstelijn / primary care data (VEKTIS)
  - Clinical data (DHD)

EXTRA SLIDES

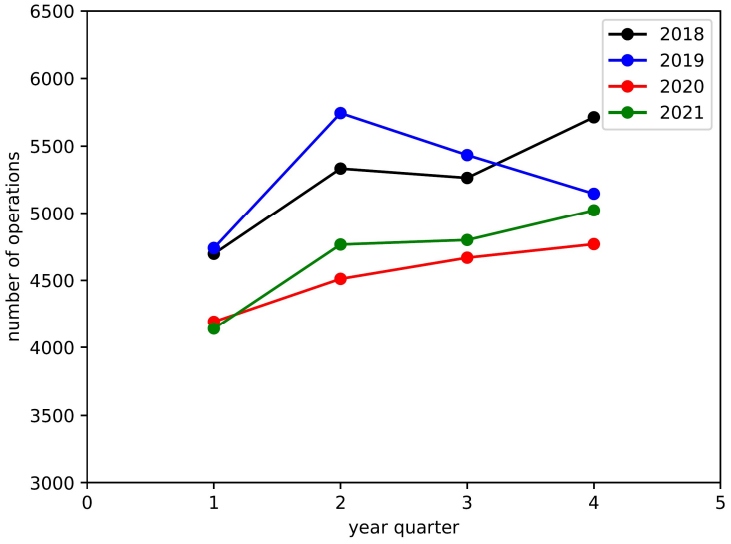
Inpatient mortality linear downward trend between 2018-2021



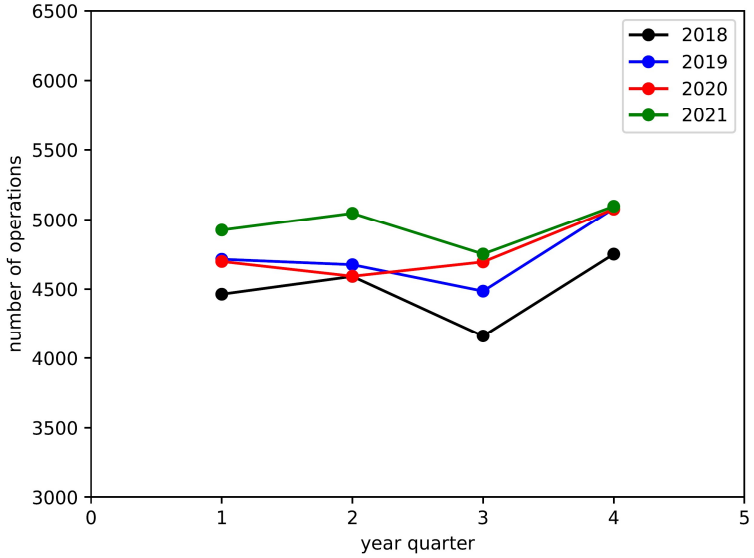


Results: Descriptive Statistics

Number of **non-acute** PTCA operations



Number of **acute** PTCA operations



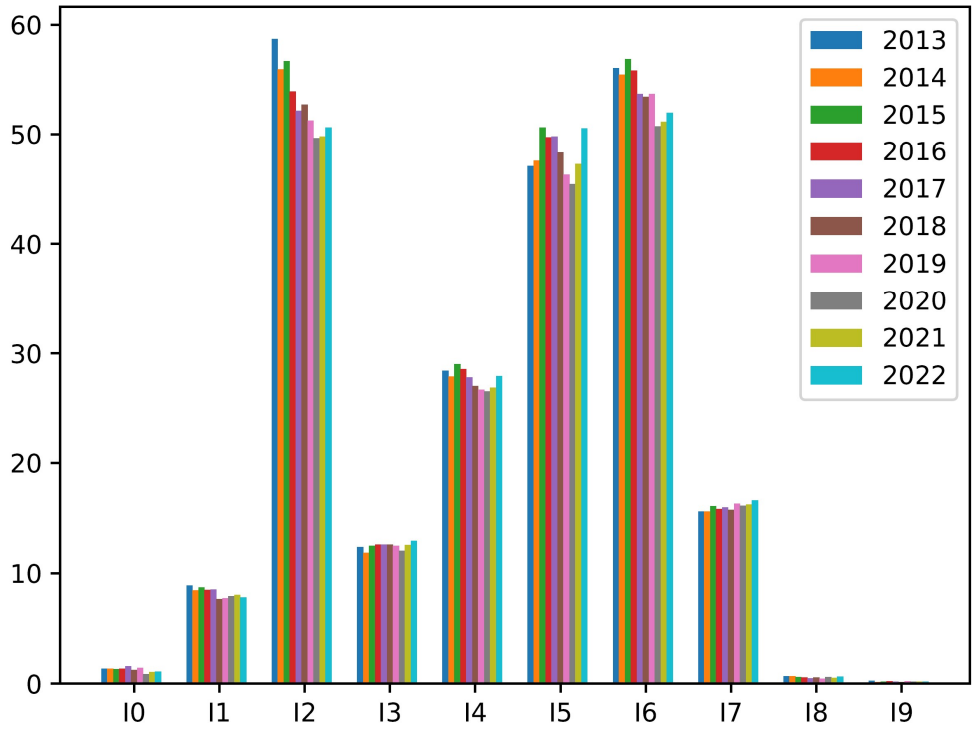
Results: Descriptive Statistics

Time To Treat (TTT). Time from **LAST** relevant diagnosis.

	Period 1	Period 2	Period 3
Acute: median time (days)	0	0	0
Acute: mean time (days)	1.2	1.9	2.9
Acute: % longer than 2 days	8%	8%	7%
Non-acute: median time (days)	4	4	5
Non-acute: mean time (days)	15	18	26
Non-acute: % longer than 2 days	56%	56%	58%

Descriptive Statistics

Number of deaths per 100,000 in ICD10 Cardiovascular “I” categories



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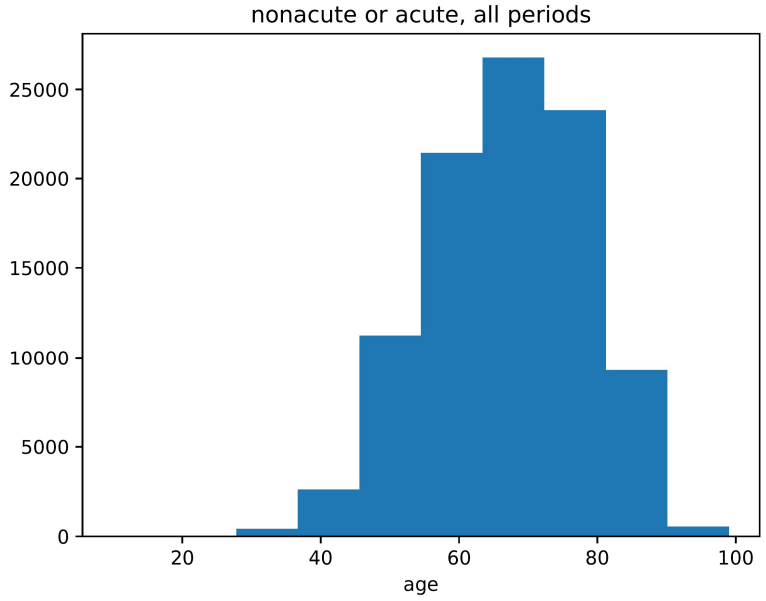

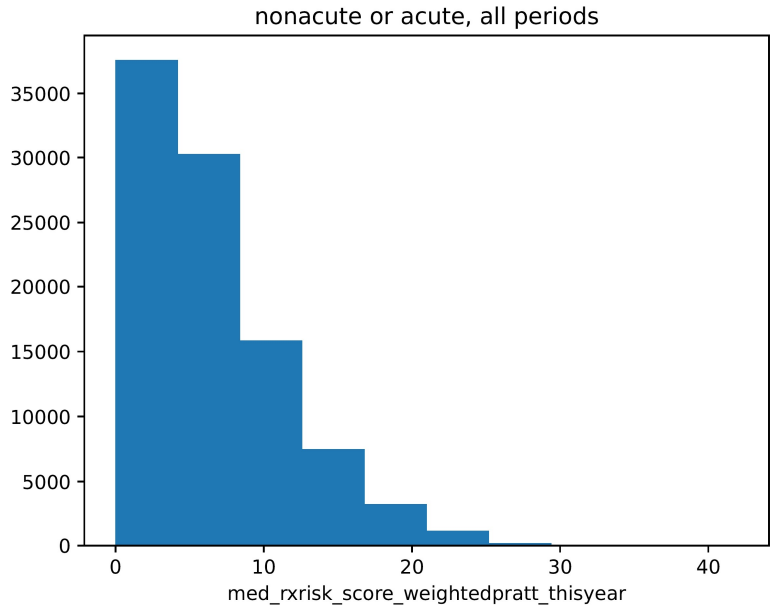

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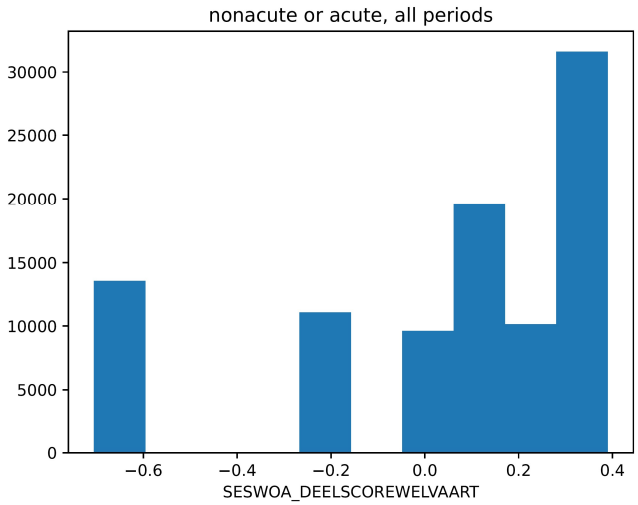

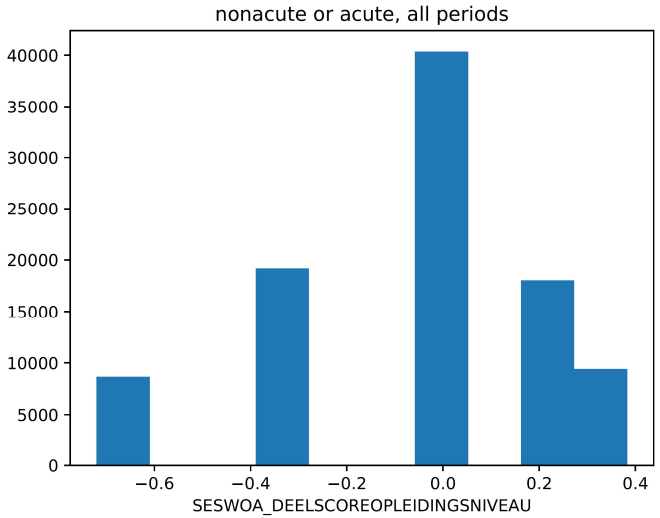

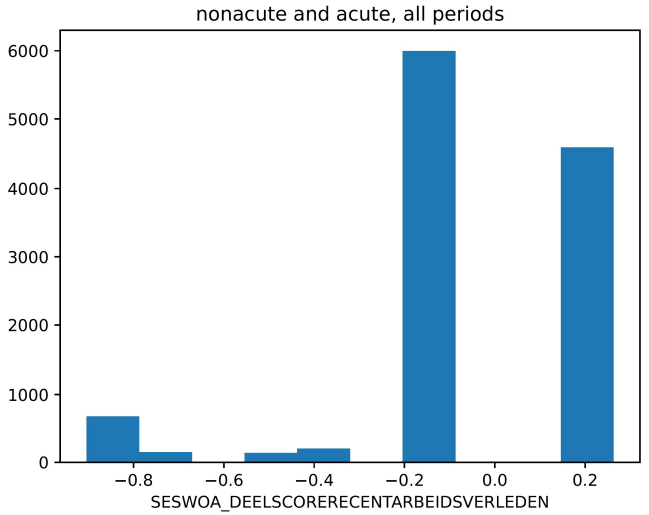

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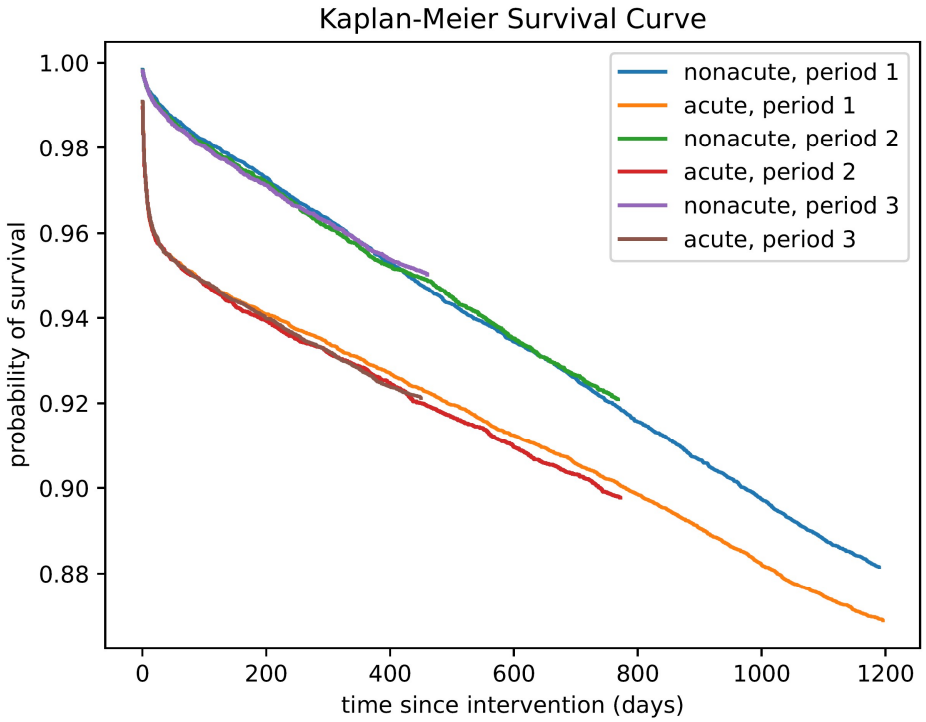

Most frequent DBC diagnosis:

Non-acute PTCA: 202, Angina Pectoris, Stabiel
Acute PTCA: 204 & 205, ST elevatie hartinfarct