Measuring quality of care in the treatment of acute coronary syndrome

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Chapter 7

Mortality differences in acute myocardial infarction patients in the Netherlands: the Weekend-effect.

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ABSTRACT:

OBJECTIVE: Several studies have shown that patients admitted with an acute myocardial infarction during the weekends have a higher mortality rate than those admitted during weekdays, possibly attributable to less trained personnel available and a lower use of medical procedures. The current study aimed to assess this 'weekend-effect' in a nationwide registry.

METHODS: In the Netherlands, all inhabitants are, by law, obliged to have health insurance and all claim data are centrally registered. In 2012 and 2013, all national diagnose-codings of STEMI and NSTEMI patients were acquired. One-year mortality rates and treatment with percutaneous coronary intervention (PCI) were compared between weekdays and weekends (holidays included).

RESULTS: In total, 59,534 patients (67±13 years, 39,545(66%) male) were included of whom 33,904(57%) had a NSTEMI. Overall 6,857(12%) patients died in the year following the acute myocardial infarction registration. In STEMI patients, no differences in one-year mortality rates were observed between admission on weekdays or weekends. In NSTEMI patients, one-year mortality was higher in those admitted during weekends (weekdays 11% versus weekends 13%, $p<0.001$). Furthermore, STEMI patients admitted during weekends were more often treated with PCI (weekdays 77% versus weekends 81%, $p<0.001$). Conversely, NSTEMI patients admitted during weekends were less often treated with PCI (weekdays 35% versus weekends 32%, $p<0.001$).

CONCLUSION: Differences in treatment and mortality rates exist between acute myocardial infarction patients admitted during weekdays and weekends. NSTEMI patients admitted during weekends are less often treated with PCI and have a higher mortality rate than patients admitted during weekdays.

INTRODUCTION

Cardiovascular disease is the most frequent cause of death worldwide and in 2012, 7.4 million of those cases were attributable to ischemic heart diseases.[1] In case of an acute myocardial infarction, timely diagnosis and treatment, potentially with coronary intervention, is of utmost importance to achieve rapid revascularization and has a large impact on survival.[2,3] Ideally, rapid access to emergency care should be equal at all time. As recommended by the ESC-guidelines for ST-segment Elevation Myocardial Infarction (STEMI), primary PCI should be performed by an experienced team within 90 minutes of the first medical contact.[1] However studies suggest that quality of emergency care may differ depending on the day of the week care is delivered. Several studies showed that patients admitted with an acute myocardial infarction on weekends had a higher mortality rate than those admitted on weekdays attributable to lower use of medical procedures.[5-10] Conversely, other studies found no differences in mortality and conclude that a 'Weekend-effect' does not exist.[11-18]

As in other Western countries, in the Netherlands, less personal is available in-hospital during weekends and an intervention team is on call and will be summoned in case of an indication for urgent intervention. Currently, a 24 hours in-hospital staff service is being debated, aiming to decrease treatment delays and improve prognosis.

The present study aims to assess whether there are differences in treatment and survival between patients with acute myocardial infarction (both STEMI and non-ST-segment Elevation Myocardial Infarction (NSTEMI)) admitted during weekdays or weekends in a nation-wide population. In the Netherlands, all inhabitants are obliged by law to have health care insurance. Claim data of all hospitals, collected by the national insurance companies, serve as a unique opportunity to assess differences on a national level. Patients with STEMI or a non-ST-segment Elevation Myocardial Infarction (NSTEMI) are assessed separately.

METHODS

Setting

This study is a retrospective cohort analysis of prospectively collected claim data of the national insurance companies. In the Netherlands, inhabitants have an obligatory health insurance and immediate access to the health care system at all times. All diagnoses and treatments provided in the hospital are coded according to a national financial coding system. Insurance companies collect all hospital claims, which are registered centrally by the national center for Health Care data and information of the national insurance com-

panies (Vektis B.V., Zeist, The Netherlands). This database was used to assess differences in practice and outcome between weekdays and weekends.

Study population

All patients admitted in 2012 and 2013 with a STEMI (coded as 0320.11.204) or a NSTEMI (coded as 0320.11.205) were included. In case of multiple diagnose codes within the study period, the date of the first admission code was used for the analysis. For the analysis of all acute myocardial infarction patients, unique patients were analyzed and subsequently only the first STEMI or NSTEMI code was used. Patients were grouped by diagnose (STEMI or NSTEMI) and by admission day of the week. Since national holidays (22 in 2012 and 2013) also have a reduced in-hospital staff service, holidays are combined with Saturdays and Sundays in the Weekend analyses. Of all patients, age, gender and treatment (PCI or no PCI during admission), were registered at baseline.

Follow-up

Mortality was registered at 6 months and 12 months after inclusion. Mortality data were retrieved from the Vektis database in which de-registration from the insurance company with given reason 'dead' is recorded. Data from the national claim database was validated by comparing national claims data of four representative hospitals to local data, which is obtained by local patient records review. The overall accuracy was above 95%.[19]

Statistical analyses

Continuous data are presented as mean ± standard deviation. Categorical data are presented as number and percentages and compared by performing a Fisher's exact test. National data were analyzed using SAS® Version 9.3 (SAS Institute, Cary NC). Data on treatment (PCI vs no PCI) and outcome will be compared between weekdays and weekends, STEMI and NSTEMI were analyzed separately.

Ethical considerations

For the use of anonymized national data, permission of the national insurance companies was provided.

Funding statement and contribution statement

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RESULTS

Patient characteristics

In 2012 and 2013, 59,534 patients were admitted for treatment of an acute myocardial infarction, mean age was 67 ± 13 years, 39,545 (66%) were male and 25,630 (43%) were diagnosed with STEMI.(**Table 1**) Treatment with PCI was performed in 31,638 (53%) of all patients. Overall, 6,862 (12%) patients died in the year following the acute myocardial infarction.

Table 1: Baseline characteristics

	Total
Total number of patients	**N = 59,534**
Age (yrs)	67 ± 13
Male gender	39,545 (66%)
Final diagnosis	
STEMI	25,630 (43%)
NSTEMI	33,904 (57%)
Treated with percutaneous coronary intervention	31,638 (53%)

Of all patients, 44,503 (75%) were admitted during weekdays and 15,031 (25%) during the weekend. Of these weekend-patients, 1,617 (11%) were admitted on a national holiday. In general, a sub-analysis of holidays compared to weekend-days showed no differences in mortality or treatment. Patients were more often admitted on a weekday (88 patients/day versus weekends 67 patients/day).(**Figure 1**) During weekdays, most patients were admitted on Monday (99 patients/Monday). During the weekends, especially a drop in the number of NSTEMI-patients admitted was observed (weekdays 51 patients/day versus weekends 35 patients/day).

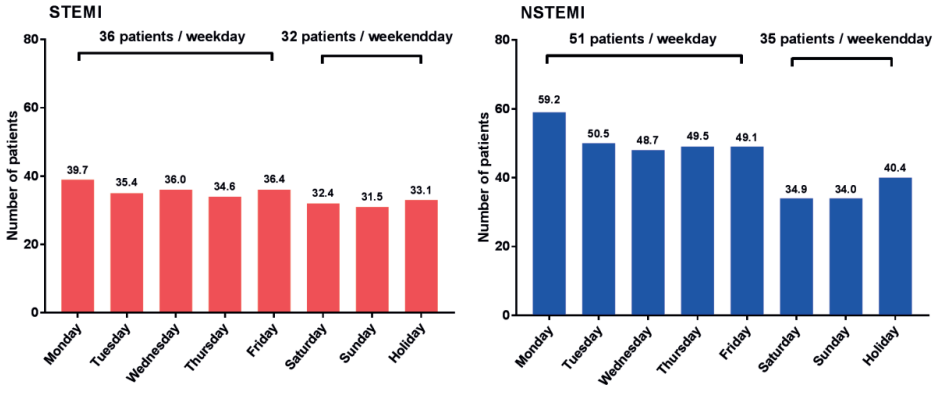

Figure 1: STEMI and NSTEMI registration per day of the week.

STEMI

Out of 25,630 STEMI-patients (mean age 65±1 3 years, 69% male gender) the majority (72%) was admitted during weekdays.(**Table 2**) Additionally, the number of STEMI-admissions was higher on weekdays (36 patients/weekday versus 32 patients/weekend-day), with the highest number of admissions on Monday (39.7 patients/Monday).(**Figure 1**) Baseline characteristics (age and gender) between weekdays and weekends were similar.

Table 2: Patient characteristics in STEMI patients.

	Total	Weekdays	Weekends	Saturdays & Sundays	Holidays
Total number of patients	**N = 25,630**	**N = 18,450**	**N = 7,180**	**N = 6,452**	**N = 728**
Age (yrs)	64 ± 13	65 ± 13	64 ± 13	64 ± 13	64 ± 13
Male gender	17,879 (70%)	12,805 (69%)	5,074 (71%)	4,561 (71%)	513 (70%)
Deceased <180 days	2,627 (10%)	1,897 (10%)	730 (10%)	661 (10%)	69 (9%)
Deceased <365 days	2,986 (12%)	2,169 (12%)	817 (11%)	740 (11%)	77 (11%)
Treated with PCI	20,016 (78%)	14,165 (77%)	5,851 (81%)	5,257 (81%)	594 (82%)

Weekends are Saturdays and Sundays combined with national holidays.

Treatment with PCI was performed in 20,016 (78%) of all STEMI-patients. However, during the weekends, more STEMI-patients were treated with PCI (weekdays 77% versus weekends 81%, p<0.001).(**Figure 2**) One year after STEMI registration, 2,986(12%) patients died of whom 2,627(10%) during the first six months. No differences in mortality rates were observed between weekdays and weekends.

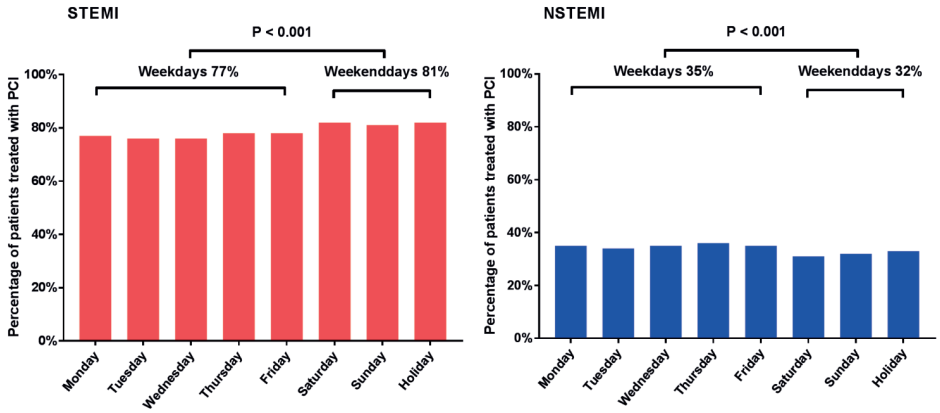

Figure 2: STEMI and NSTEMI patients per admission day of the week for receiving a PCI treatment during their admission.

NSTEMI

In general, NSTEMI patients (n=33,904) were older (mean age 69±13 years) and the proportion of male gender was smaller (64%) compared to STEMI patients.(**Table 3**) Registration of NSTEMI was higher during weekdays (51 NSTEMI patients/weekday versus 35 STEMI patients/weekend-day), with the highest number of admissions on Monday (59 patients/Monday).(**Figure 1**) Baseline characteristics (age and gender) between patients admitted during weekdays and weekends were comparable.

Table 3: Patient characteristics in NSTEMI patients.

	Total	Weekdays	Weekends	Saturdays & Sundays	Holidays
Total number of patients	**N = 33,904**	**N = 26,053**	**N = 7,851**	**N = 6,962**	**N = 889**
Age (yrs)	69 ± 13	69 ± 13	69 ± 13	69 ± 13	69 ± 13
Male gender	21,666 (64%)	16,701 (64%)	4,965 (63%)	4,406 (63%)	559 (63%)
Deceased <180 days	2,849 (8%)	2,119 (8%)	730 (9%)	664 (10%)	66 (7%)
Deceased <365 days	3,876 (11%)	2,881 (11%)	995 (13%)	897 (13%)	98 (11%)
Treated with PCI	11,622 (34%)	9,134 (35%)	2,488 (32%)	2,196 (32%)	292 (33%)

Weekends are Saturdays and Sundays combined with national holidays.

Treatment with PCI was performed in 11,622 (34%) of all NSTEMI-patients. Patients admitted on a weekend-day were less frequently treated with PCI during their admission than those admitted on a weekday (32% versus 35%; p<0.001). (**Figure 2**)

Within one year after NSTEMI, 3,876 (11%) patients died, of whom 2,849 (8%) died during the first six months. Significant differences in mortality rates were observed between patients admitted during weekdays and weekends six months after admission (weekdays

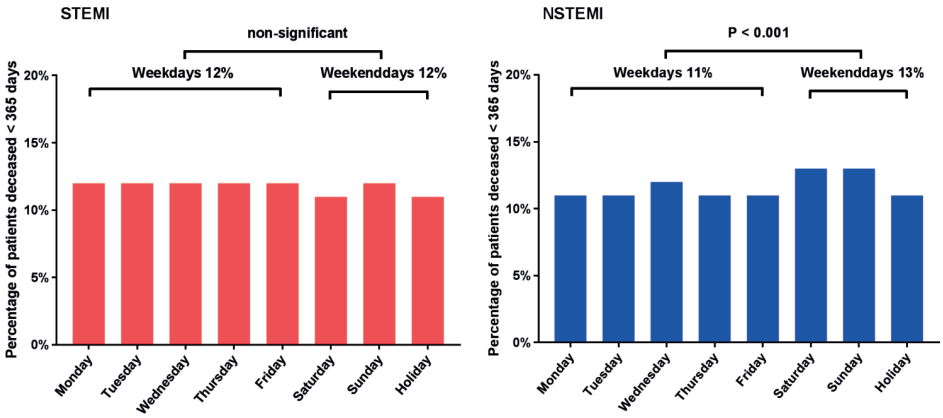

Figure 3: STEMI and NSTEMI patients per admission day of the week for mortality rate 365 days after admission.

8% versus weekends 9%, p=0.001) and one year after admission in NSTEMI patients (weekdays 11% versus weekends 13%, p<0.001).

DISCUSSION

In this study on the 'Weekend-effect' in patients with an acute myocardial infarction in the Netherlands, the findings can be summarized as follows: (i) NSTEMI-patients who are admitted during weekends are less frequently treated with PCI and have a higher mortality rate compared to NSTEMI-patients during weekdays; (ii) STEMI patients admitted during weekends are more often treated with PCI compared to STEMI-patients during weekdays; (iii) The admission rate for a myocardial infarction is higher on Monday and NSTEMI-patients are less often admitted during weekends compared to weekdays.

Treatment and mortality differences

Since the study of Bell et al. in 2001, various studies have been conducted to test the existence of a 'Weekend-effect', which postulates that reduced staffing leads to a higher mortality due to a longer time to intervention and lower rate of PCI during weekends.(20) Numerous studies show in acute myocardial infarction patients that this 'Weekend-effect' does not exist and that there is no significant difference in mortality between patients admitted to the hospital on weekends compared to weekdays.[11-18] However, other studies did find a significantly higher mortality and lower rates of performed interventions during weekends.[6-10] Furthermore, a large meta-analysis of 48 studies by Sorita et al. showed a higher mortality during off-hours for both in-hospital and 30 day mortality, especially in STEMI patients.[21] This may partially be attributed to longer door-to-balloon times during off-hours for STEMI-patients.

The current study shows a higher mortality rate in NSTEMI patients admitted during weekends (week 11% versus weekend 13%), which is possibly attributable to a lower number of PCI's performed during weekends (week 35% versus weekend 32%). However, a correlation analysis is not provided, only previous studies could support this hypothesis. A recent study of the British Myocardial Ischaemia National Audit Project (MINAP)-registry showed that the observed increased survival after NSTEMI was related to the higher use of invasive coronary strategies (such as PCI), more strongly than baseline clinical risk factors or an increased use of pharmacological therapies.[22] No previous Dutch study concerning the 'Weekend effect' in NSTEMI patients is available.

In STEMI-patients, no mortality differences were found. This is in line with a previous single center study from the Netherlands, analyzing 4,532 STEMI patients with a primary PCI for

the incidence of all-cause mortality at 30-day and 4-year follow-up.[17] In the Netherlands, a dedicated regional care collaboration between general practitioners, ambulance services and hospitals is assigned to provide consistent quality of care in patients with angina in order to close the mortality gap between off-hours and regular hours. After a pre-hospital electrocardiographic diagnosis is made by the ambulance, patients are immediately sent to the catherization room which results in reduced ischemic times and a lower mortality, especially in STEMI patients.[23-25] Moreover, acute coronary care for STEMI patients is organized in a limited number of specialized PCI-centers in the Netherlands. Probably, this strict pathway and dedicated regional collaboration for STEMI is the reason for the similar mortality during weekdays or weekends. Whereas the less stricter pathway for NSTEMI patients, could lead to a higher mortality ratio in NSTEMI patients during the weekends compared to weekdays. In which a delay in the acute treatment phase due to the diagnostic analysis at the emergency department or a lower number of available beds and treatment capacity could play a role. In this study, it is unknown whether this lower amount of performed interventions is due to the availability of competent staff admitted during weekends. Furthermore, the higher mortality ratio for NSTEMI patients during the weekends compared to weekdays may also be explained by a sicker population with more comorbidities. Previous studies, especially performed in STEMI populations, showed more severe patients (measured by the presence of cardiogenic shock or Killip Class) being admitted during weekends [26-28], whereas other studies found no differences.[15, 17, 29-32] Finally, age and gender differences between weekdays and the weekend could play a role. Other studies showed that mainly younger and male patients are admitted during the weekends.[5, 8, 9, 11, 16, 26, 28, 29, 32] However, this study did not found differences in age and gender between weekdays and weekends in STEMI and NSTEMI, which is observed in other studies.[7, 17, 27, 30, 31] Surprisingly, the STEMI patients admitted during weekends are more often treated with PCI compared to STEMI-patients during weekdays. This may be caused by the limited availability of catherization rooms during weekdays due to scheduled elective procedures. In summary, previous studies show conflicting results on mortality differences during weekends or weekdays. This study shows differences in treatment and mortality on a national level. However, it remains unclear if mortality differences can be attributed to differences in treatment, patient population or national organization of health care.

Differences in patients admissions

A lower number of NSTEMI patients during weekends and a higher number of NSTEMI patients and even STEMI patients on Monday, could possibly be caused by patient delay or referral delay during the weekends. For acute presentations like STEMI and NSTEMI, one would expect no differences during the week-days and weekend-days. However, previous research in acute stroke care and the emergency department, also show an (unexplained) higher admission rate on Mondays.[14, 33] Furthermore, a study by Willich et al. in 1994

showed an increased occurrence of acute myocardial infarction on Monday in the working population, according to the authors possibly being caused by a change in activity pattern and stress factors due to starting a workday.[34] More research is necessary to identify what kind of patients are admitted on Mondays.

Strengths & limitations

This analysis composes a large number of patients from a nationwide registry. The use of claim data is validated in a previous study.[19] However, some important limitations should be addressed. First and as addressed before, due to the limitations of this claim data set, no adjustment for patient characteristics and treatment characteristics (staff availability, door-to-balloon times) is performed. Therefore, a final conclusion regarding the 'weekend-effect is not possible. Secondly, no analysis could be done in which night-time versus day-time was assessed. However, previous registrations did not show large differences between night-time versus day-time and weekday versus weekend day.[21] Third, this study is study is comparable to countries who has the same organization of care during the weekends. However, this manuscript shares its limitations with all weekend-studies. Large differences in patient characteristics, treatment characteristics and organization of care can differ per region and therefore the existence of a weekend-effect can differ.

International perspective

The national or regional organization of healthcare could be a factor in the existence of a 'Weekend-effect' and therefore current studies are supportive to explore the variation in quality of care (inter)nationally. Future analysis in the Netherlands is required to explore why differences exist and whether these are caused by patient factors (sicker patients) or organization of care (i.e. staff availability and strict care pathways), particularly in NSTEMI patients.

CONCLUSION

In the Netherlands, differences in treatment and mortality exist between acute myocardial infarction patients admitted during weekdays and weekends. NSTEMI patients admitted during weekends are less often treated with PCI during their hospital admission and have a higher mortality rate than patients admitted during weekdays.

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