

When Is the Proper Time for Complex PCI?

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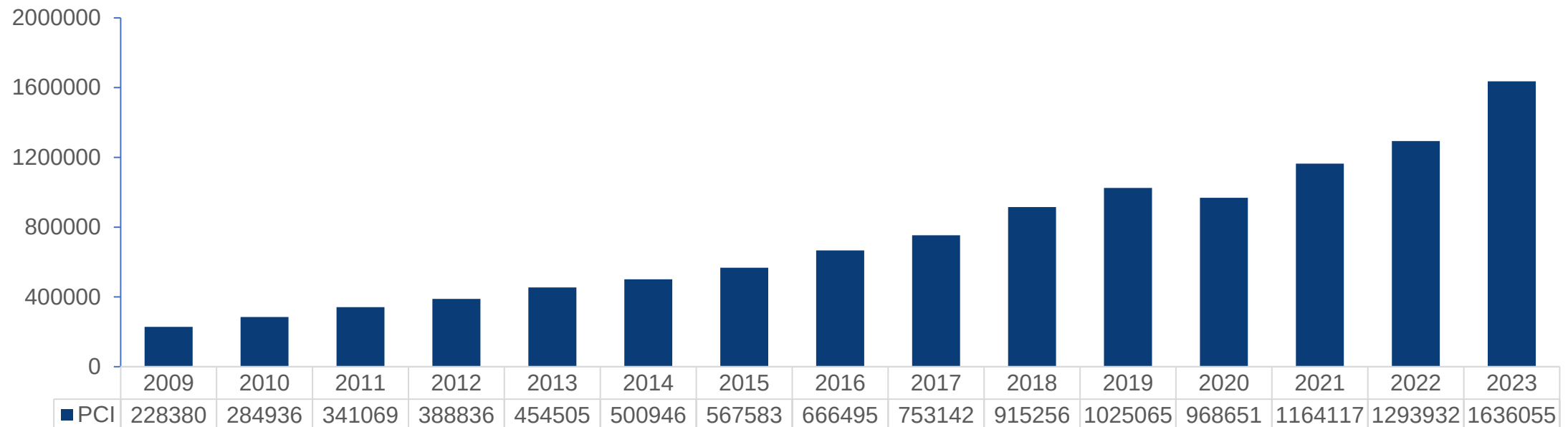
Disclosure

- I, (Kefei Dou) DO NOT have any potential conflict of interest to declare

Background

PCI Cases Continue to Grow, and It Prolongs the Working Hours of Operators

- National report on cardiovascular report showed **an increasing number of PCI cases since 2009, and the number of PCI procedures exceeded 1.63 million in 2023.**
- The sharp increase in the PCI procedures has significantly extended the working hours of interventional cardiologists in China.



Background

Operators with Overtime Work may Have Declined Performances during Procedures

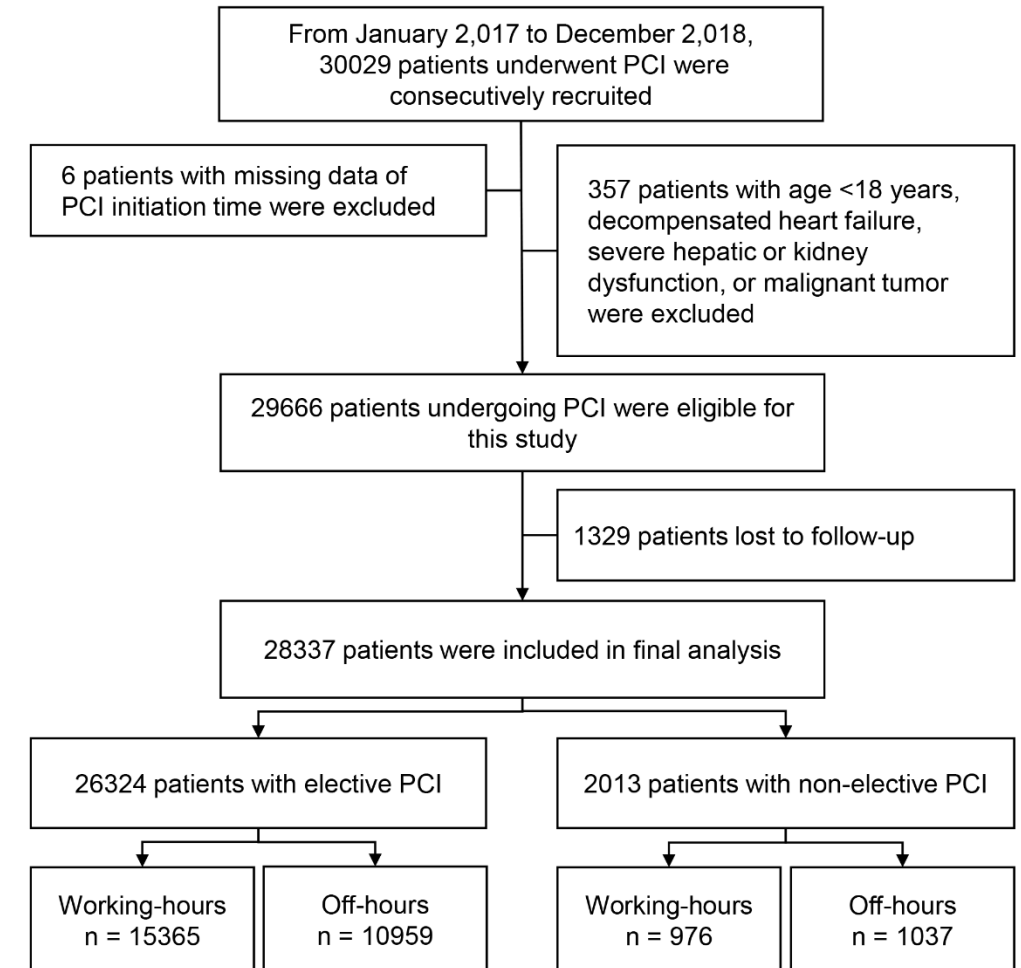
- Operators with overtime works, high occupational stress and fatigue could experience a decline in executive performance and decision-making ability
- Whether PCI procedures performed by operators in different condition at different time periods affect the prognosis?

JACC Cardiovasc Interv 2016;9:2086-2093 *Am J Epidemiol.* 2009;169(5):596-605.

Study Design

An Observational Study Aiming to Determine PCI Scheduling and Outcomes

- Study population: **28337 consecutive patients undergoing PCI procedures, from January 2017 to December 2018, were included.**
- Study groups: **patients were stratified by whether they underwent elective PCI, subsequently by PCI scheduling (working-hours procedures [8:00-17:00] and off-hours procedures [later than 17:00]).**



Study Design

Outcomes and Definitions

- Outcomes:
 - I. **3-year major adverse cardiac events (MACE)** was defined as composite cardiac death, target-vessel myocardial infarction and ischemia-driven target vessel revascularization.
 - II. **Procedure success** was defined as achievement of residual stenosis of <50% and final Thrombolysis In Myocardial Infarction (TIMI) flow grade 3 in all treated lesions.
- **Elective PCI** were defined as planned, deferrable, non-urgent/non-emergent procedures
- **Complex PCI** was defined as any of the following criteria: **chronic total occlusion as target lesion, severe calcification lesion, left main intervention, bifurcation with 2 stents implanted, or surgical bypass graft as target vessel, 3 vessels treated, ≥3 stents implanted, ≥3 lesions treated, total stent length >60 mm,**

Results

Baseline Characteristics

- In patients undergoing **elective PCI**, those underwent working-hours procedures were more likely to be male, with higher incidence of prior MI and lower levels of creatinine clearance

	Elective PCI			Non-elective PCI		
	Working-hours n = 15365	Off-hours n = 10959	P value	Working- hours n = 976	Off-hours n = 1037	P value
Age, years	59.56±10.10	59.63±9.92	0.610	61.34±11.98	59.89±11.85	0.006
Male sex	11911 (77.5)	8377 (76.4)	0.041	735 (75.3)	844 (81.4)	0.001
BMI, kg/m ²	25.94±3.20	25.99±3.25	0.176	25.89±3.51	26.22±3.57	0.038
CAD presentations			0.912			-
CCS	5924 (38.6)	4217 (38.5)				
ACS	9441 (61.4)	6742 (61.5)		976 (100.0)	1037 (100.0)	
Hypertension	9879 (64.3)	7046 (64.3)	1.000	575 (58.9)	590 (56.9)	0.383
Diabetes	5171 (33.7)	3710 (33.9)	0.746	304 (31.1)	320 (30.9)	0.927
Hyperlipidemia	12020 (78.2)	8483 (77.4)	0.116	687 (70.4)	739 (71.3)	0.702
Previous MI	3758 (24.5)	2545 (23.2)	0.021	541 (55.4)	602 (58.1)	0.254
Previous PCI	3882 (25.3)	2705 (24.7)	0.289	329 (33.7)	410 (39.5)	0.008
Family history of CAD	1836 (11.9)	1233 (11.3)	0.085	147 (15.1)	130 (12.5)	0.114
Current smoker	4770 (31.0)	3400 (31.0)	0.983	335 (34.3)	377 (36.4)	0.365
LVEF, %	62.06±6.48	62.11±6.36	0.515	56.26±8.31	56.01±7.97	0.500
Creatine clearance, ml/min	87.94±24.15	88.92±25.15	0.001	92.10±33.62	94.53±32.97	0.102

Results

Baseline Characteristics

- In patients undergoing **non-elective PCI**, those underwent working-hours procedures were older and more likely to be female, with higher incidence of prior PCI and lower levels of BMI.

	Elective PCI			Non-elective PCI		
	Working-hours n = 15365	Off-hours n = 10959	P value	Working- hours n = 976	Off-hours n = 1037	P value
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Results

Angiographic Findings

- Among **elective PCI procedures**

- Working-hours procedures had more complex PCI** (such as left main and CTO as target lesions), with higher numbers of treated lesions and total implanted stent, and a longer length of total implanted stent.
- Working-hours PCI was more likely to succeed** and had longer procedure time and a higher frequency of IVUS use

<i>Elective PCI</i>	Working-hours n = 15365	Off-hours n = 10959	P value
Left main disease	1194 (7.8)	839 (7.7)	0.748
Left main PCI	681 (4.4)	405 (3.7)	0.003
3-vessel disease	6527 (42.5)	4618 (42.1)	0.590
Treated vessel = 3	74 (0.5)	37 (0.3)	0.093
CTO as target lesions	1700 (11.1)	1088 (9.9)	0.003
Ostial lesions	1977 (12.9)	1201 (11.0)	<0.001
Thrombotic lesions	176 (1.1)	139 (1.3)	0.397
Severe tortuosity	378 (2.5)	264 (2.4)	0.822
Severe calcification	476 (3.1)	340 (3.1)	1.000
Bifurcation lesions	3037 (19.8)	2027 (18.5)	0.010
Two-stent strategy	364 (2.4)	220 (2.0)	0.055
Arterial or venous graft PCI	94 (0.6)	54 (0.5)	0.234
Number of treated lesions	1.44±0.70	1.39±0.67	<0.001
Treated lesions ≥3	1186 (7.7)	753 (6.9)	0.010
Total stent number	2.52±2.59	2.37±2.25	<0.001
Total stent number ≥3	5068 (33.0)	3331 (30.4)	<0.001
Total stent length	41.32±31.49	40.18±30.33	0.004
Total stent length ≥60 mm	3461 (22.5)	2330 (21.3)	0.015
Complex PCI	7149 (46.5)	4741 (43.3)	<0.001
Procedural success	14224 (92.6)	10039 (91.6)	0.004
Procedural time	36.82±27.11	34.43±25.01	<0.001
IVUS guidance	1778 (11.6)	1153 (10.5)	0.008

Results

Angiographic Findings

- Among **non-elective PCI procedures**
 - Lesions and procedural characteristics were balanced between the two groups
 - Success rate and procedural time are comparable**

<i>Non-elective PCI</i>	Working-hours n = 976	Off-hours n = 1037	P value
Left main disease	77 (7.9)	95 (9.2)	0.347
Left main PCI	36 (3.7)	39 (3.8)	1.000
3-vessel disease	412 (42.2)	452 (43.6)	0.564
Treated vessel = 3	5 (0.5)	2 (0.2)	0.402
CTO as target lesions	73 (7.5)	74 (7.1)	0.833
Ostial lesions	133 (13.6)	114 (11.0)	0.083
Thrombotic lesions	229 (23.5)	269 (25.9)	0.217
Severe tortuosity	37 (3.8)	39 (3.8)	1.000
Severe calcification	27 (2.8)	34 (3.3)	0.589
Bifurcation lesions	168 (17.2)	179 (17.3)	1.000
Two-stent strategy	27 (2.8)	18 (1.7)	0.158
Arterial or venous graft PCI	8 (0.8)	7 (0.7)	0.906
Number of treated lesions	1.45±0.74	1.42±0.73	0.199
Treated lesions ≥3	90 (9.2)	100 (9.6)	0.805
Total stent number	2.41±2.81	2.22±2.36	0.329
Total stent number ≥3	279 (28.6)	277 (26.7)	0.373
Total stent length	39.19±32.93	38.66±31.31	0.953
Total stent length ≥60 mm	201 (20.6)	206 (19.9)	0.725
Complex PCI	383 (39.2)	389 (37.5)	0.452
Procedural success	877 (89.9)	941 (90.7)	0.551
Procedural time	42.04±40.38	41.68±33.75	0.827
IVUS guidance	115 (11.8)	151 (14.6)	0.076

Results

Medications

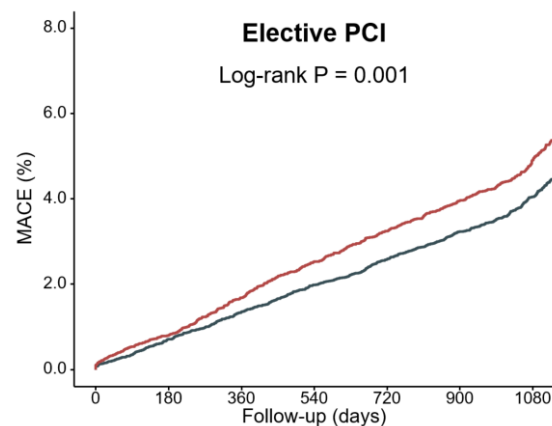
- **Medication prescriptions at discharge were similar** between working-hours and off-hours groups in patients undergoing either elective or non-elective PCI procedures

	Elective PCI			Non-elective PCI		
	Working-hours n = 15365	Off-hours n = 10959	P value	Working-hours n = 976	Off-hours n = 1037	P value
Aspirin	15241 (99.2)	10881 (99.3)	0.423	953 (97.6)	1017 (98.1)	0.610
P2Y₁₂ inhibitors	15156 (98.6)	10793 (98.5)	0.322	956 (98.0)	1020 (98.4)	0.604
Clopidogrel	12306 (80.1)	8932 (81.5)	0.004	580 (59.4)	572 (55.2)	0.059
Ticagrelor	2858 (18.6)	1867 (17.0)	0.001	378 (38.7)	452 (43.6)	0.030
ACE inhibitor or ARB	8122 (52.9)	5828 (53.2)	0.617	649 (66.5)	722 (69.6)	0.145
β-blocker	11142 (72.5)	7833 (71.5)	0.066	861 (88.2)	909 (87.7)	0.751
Statins	15118 (98.4)	10759 (98.2)	0.194	974 (99.8)	1034 (99.7)	1.000

Results

Clinical Outcomes

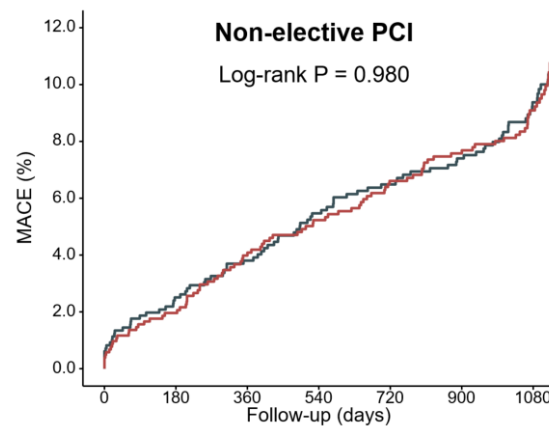
- **Working hours elective PCI had lower rates of 3-year MACE, hard endpoints, cardiac death and Ischemia-driven TLR than off-hours procedures**
- **Outcomes were similar between the two groups in non-elective PCI procedures.**



Number at risk

Working-hours	15365	15117	14879	14644	14510	14366	11797
Off-hours	10959	10796	10616	10426	10322	10217	8369

Follow-up (days)



Number at risk

Working-hours	976	934	916	890	879	867	679
Off-hours	1037	1001	973	954	936	922	748

Follow-up (days)

	Working-hours	Off-hours	P value
Elective PCI	n = 15365	n = 10959	
MACE	635 (4.1)	545 (5.0)	0.001
Hard endpoint	361 (2.3)	308 (2.8)	0.020
All-cause death	294 (1.9)	231 (2.1)	0.193
Cardiac death	181 (1.2)	161 (1.5)	0.041
MI	182 (1.2)	144 (1.3)	0.348
TVMI	135 (0.9)	115 (1.0)	0.158
Revascularization	1026 (6.7)	759 (6.9)	0.431
Ischemia-driven TLR	343 (2.2)	292 (2.7)	0.025
Non-elective PCI	n = 976	n = 1037	
MACE	91 (9.3)	98 (9.5)	0.980
Hard endpoint	72 (7.4)	86 (8.3)	0.491
All-cause death	56 (5.7)	59 (5.7)	0.946
Cardiac death	45 (4.6)	40 (3.9)	0.380
MI	28 (2.9)	43 (4.1)	0.130
TVMI	25 (2.6)	30 (2.9)	0.669
Revascularization	74 (7.6)	84 (8.1)	0.743
Ischemia-driven TLR	26 (2.7)	34 (3.3)	0.449

Results

Clinical Outcomes (off-hour PCI as reference)

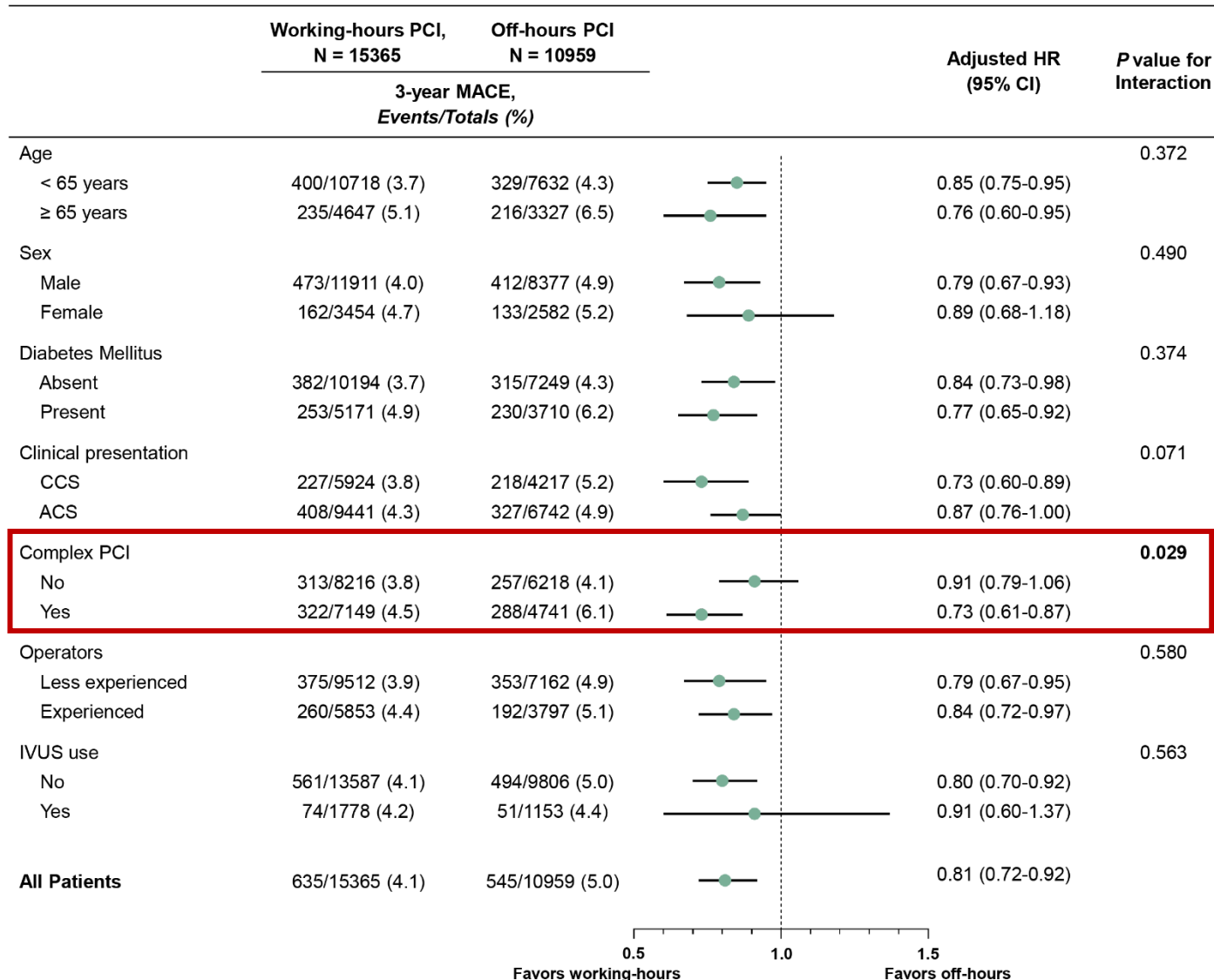
	Unadjusted HR (95%CI)	P value	Adjusted HR (95%CI)*	P value
<i>Elective PCI procedures</i>				
MACE	0.83 (0.74-0.93)	0.001	0.81 (0.72-0.92)	0.001
Hard endpoint	0.83 (0.72-0.97)	0.020	0.81 (0.67-0.98)	0.030
All-cause death	0.89 (0.75-1.06)	0.193	0.88 (0.71-1.08)	0.219
Cardiac death	0.80 (0.65-0.99)	0.041	0.78 (0.60-1.01)	0.059
MI	0.90 (0.72-1.12)	0.348	0.88 (0.71-1.09)	0.244
TVMI	0.84 (0.65-1.07)	0.159	0.82 (0.65-1.03)	0.081
Revascularization	0.96 (0.88-1.06)	0.431	0.95 (0.89-1.03)	0.222
Ischemia-driven TLR	0.84 (0.72-0.98)	0.025	0.83 (0.71-0.97)	0.021
<i>Non-elective PCI procedures</i>				
MACE	0.99 (0.75-1.33)	0.980	0.96 (0.67-1.39)	0.844
Hard endpoint	0.90 (0.66-1.23)	0.491	0.85 (0.57-1.25)	0.396
All-cause death	1.01 (0.70-1.46)	0.946	0.90 (0.59-1.38)	0.626
Cardiac death	1.21 (0.79-1.85)	0.380	1.07 (0.68-1.69)	0.761
MI	0.69 (0.43-1.12)	0.132	0.70 (0.42-1.17)	0.173
TVMI	0.89 (0.52-1.52)	0.670	0.89 (0.49-1.62)	0.698
Revascularization	0.95 (0.69-1.30)	0.743	0.94 (0.67-1.33)	0.736
Ischemia-driven TLR	0.82 (0.49-1.37)	0.450	0.82 (0.46-1.46)	0.503

- Multivariable Cox models showed **prognostic benefits of working hours elective PCI** in terms of reduced risk of 3-year MACE, hard endpoints and ischemia-driven TLR

*Model adjusted for age, sex, ACS presentations, hypertension, diabetes, previous MI, previous PCI, previous CABG, LVEF, creatinine clearance, SYNTAX score, complex PCI and IVUS use as fixed effects, **and operators as random effect.**

Results

Subgroup Analysis for the Scheduling and 3-year MACE in Elective PCI



- The association between working hours PCI and lower 3-year MACE risk was more evident in patients who underwent elective complex PCI than those who underwent non-complex PCI ($P_{\text{interaction}} = 0.029$)

Off-hours PCI as referents

*Model adjusted for age, sex, ACS presentations, hypertension, diabetes, previous MI, previous PCI, previous CABG, LVEF, creatinine clearance, SYNTAX score, complex PCI and IVUS use as fixed effects, and operators as random effect.

Results

Refined Analyses for the Specific Type of Elective Complex PCI

- Significant associations between working hours PCI and lower risk of 3-year MACE were observed in cases with CTO, severe calcified lesions, or left main as target lesions

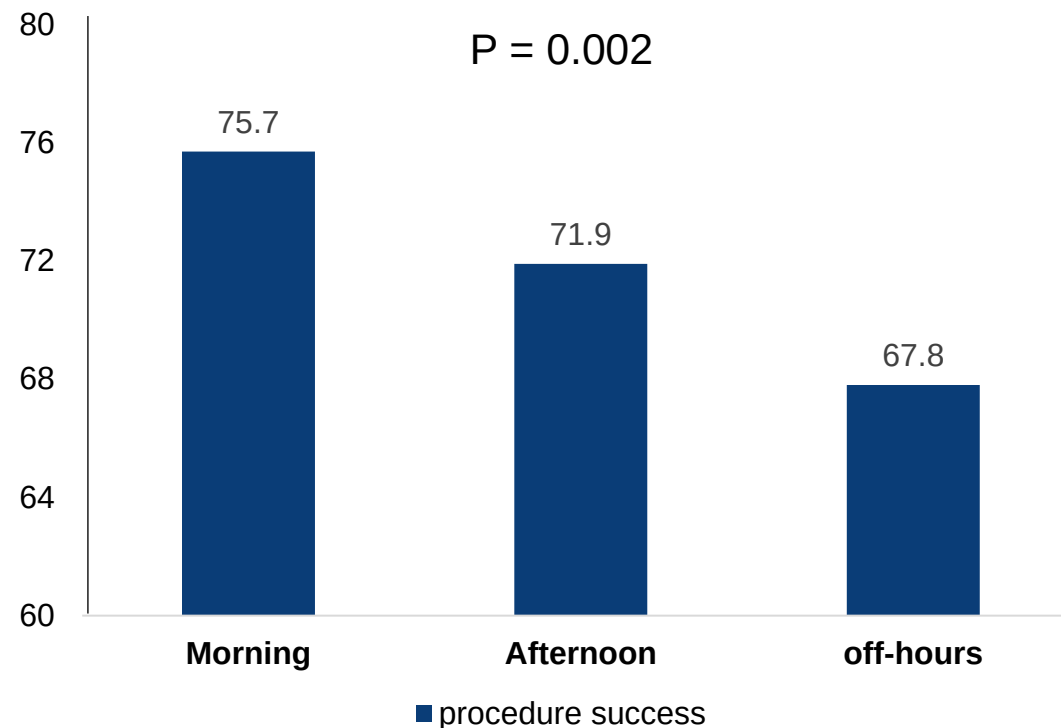
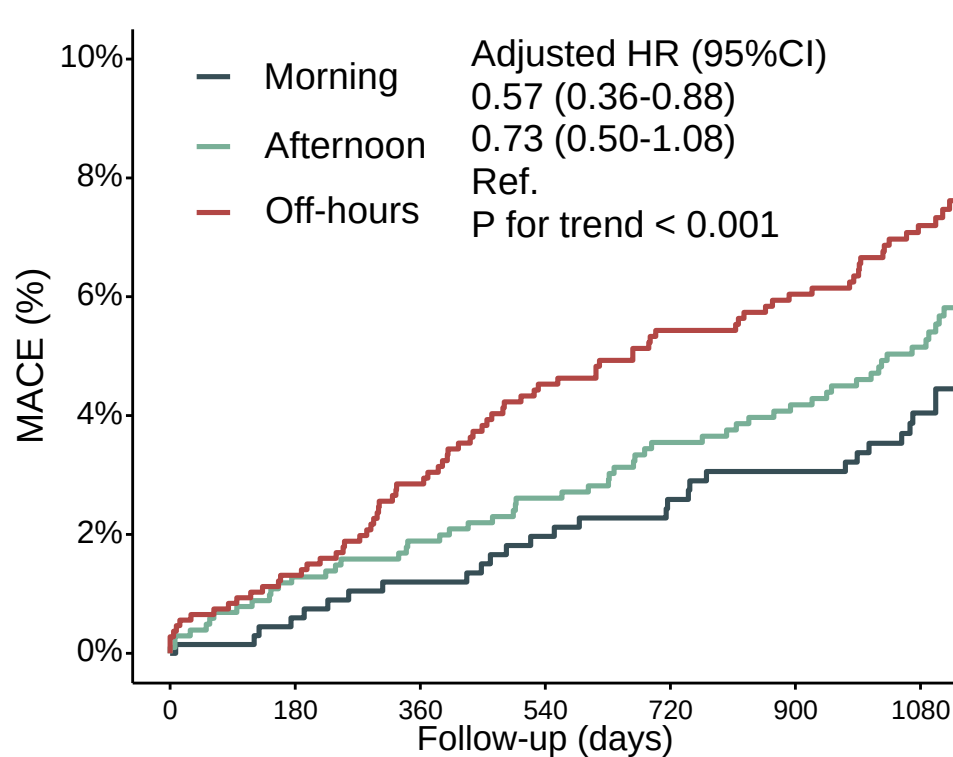
	Working-hours Events/totals (%)	Off-hours Events/totals (%)	Adjusted HR (95%CI)	P value	
≥3 stents implanted	213/5068 (4.2)	177/3331 (5.3)	0.79 (0.65-0.96)	0.016	
≥3 lesions treated	72/1186 (6.1)	44/753 (5.8)	1.08 (0.75-1.57)	0.671	
Total stent length ≥60 mm	152/3461 (4.4)	132/2330 (5.7)	0.76 (0.57-1.02)	0.068	
Bifurcation with 2-stents implanted	13/364 (3.6)	12/220 (5.5)	0.69 (0.32-1.51)	0.354	
CTO as target lesion	83/1700 (4.9)	78/1088 (7.2)	0.65 (0.48-0.89)	0.008	
Severe calcification	26/476 (5.5)	30/340 (8.8)	0.57 (0.33-0.99)	0.047	
Left main intervened	30/681 (4.4)	31/405 (7.7)	0.56 (0.33-0.97)	0.037	
Surgical bypass graft as target vessel	10/94 (10.6)	6/54 (11.1)	0.99 (0.28-3.58)	0.999	

*Model adjusted for age, sex, ACS presentations, hypertension, diabetes, previous MI, previous PCI, previous CABG, LVEF, creatinine clearance, SYNTAX score, and IVUS use as fixed effects, and operators as random effect.

Results

Exploration on the Optimal PCI Time for CTO

- Refined the working hours PCI procedures into morning (8:00-12:00) and afternoon (12:00-17:00) PCI to further explore the optimal time for CTO interventions
- Morning PCI for CTO lesions had the lowest 3-year MACE risk and the highest procedure success rate**



Conclusions and Clinical Implications

- The present study provided novel insights and had valuable implications for the PCI scheduling.
 - I. For elective PCI procedures, working hours PCI was associated with improved clinical outcomes compared to off-hours procedures, especially for complex PCI. Notably, PCI for specific lesion subsets (such as CTO) should be moved up to the morning.
 - II. For non-elective PCI procedures, clinical and procedure outcomes were similar between working hours and off-hours PCI procedures.

Thank you !

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