Admission Glucose and In-hospital Mortality after Acute Myocardial Infarction in Patients with or without Diabetes: A Cross-sectional Study

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Abstract

Background: Hyperglycemia on admission has been found to elevate risk for mortality and adverse clinical events after acute myocardial infarction (AMI), but there are evidences that the relationship of blood glucose and mortality may differ between diabetic and nondiabetic patients. Prior studies in China have provided mixed results and are limited by statistical power. Here, we used data from a large, nationally representative sample of patients hospitalized with AMI in China in 2001, 2006, and 2011 to assess if admission glucose is of prognostic value in China and if this relationship differs depending on the presence or absence of diabetes.

Methods: Using a nationally representative sample of patients with AMI in China in 2001, 2006, and 2011, we categorized patients according to their glucose levels at admission (<3.9, 3.9–7.7, 7.8–11.0, and ≥11.1 mmol/L) and compared in-hospital mortality across these admission glucose categories, stratified by diabetes status. Among diabetic and nondiabetic patients, separately, we employed logistic regression to assess the differences in outcomes across admission glucose levels while adjusting for the same covariates.

Results: Compared to patients with euglycemia (5.8%), patients with moderate hyperglycemia (13.1%, odds ratio [*OR*] = 2.44, 95% confidence interval [*CI*, 2.08–2.86]), severe hyperglycemia (21.5%, *OR* = 4.42, 95% *CI* [3.78–5.18]), and hypoglycemia (13.8%, *OR* = 2.59, 95% *CI* [1.68–4.00]), all had higher crude in-hospital mortality after AMI regardless of the presence of recognized diabetes mellitus. After adjustment for patients' characteristics and clinical status, however, the relationship between admission glucose and in-hospital mortality was different for diabetic and nondiabetic patients (*P* for interaction = 0.045). Among diabetic patients, hypoglycemia (*OR* = 3.02, 95% *CI* [1.20–7.63]), moderate hyperglycemia (*OR* = 1.75, 95% *CI* [1.04–2.92]), and severe hyperglycemia (*OR* = 2.97, 95% *CI* [1.87–4.71]) remained associated with elevated risk for mortality, but among nondiabetic patients, only patients with moderate hyperglycemia (*OR* = 2.34, 95% *CI* [1.93–2.84]) and severe hyperglycemia (*OR* = 3.92, 95% *CI* [3.04–5.04]) were at elevated mortality risk and not hypoglycemia (*OR* = 1.12, 95% *CI* [0.60–2.08]). This relationship was consistent across different study years (*P* for interaction = 0.900).

Conclusions: The relationship between admission glucose and in-hospital mortality differs for diabetic and nondiabetic patients. Hypoglycemia was a bad prognostic marker among diabetic patients alone. The study results could be used to guide risk assessment among AMI patients using admission glucose.

Trial Registration: www.clinicaltrials.gov, NCT01624883; https://clinicaltrials.gov/ct2/show/NCT01624883.

Key words: Acute Myocardial Infarction; Blood Glucose; Diabetes Mellitus; Mortality

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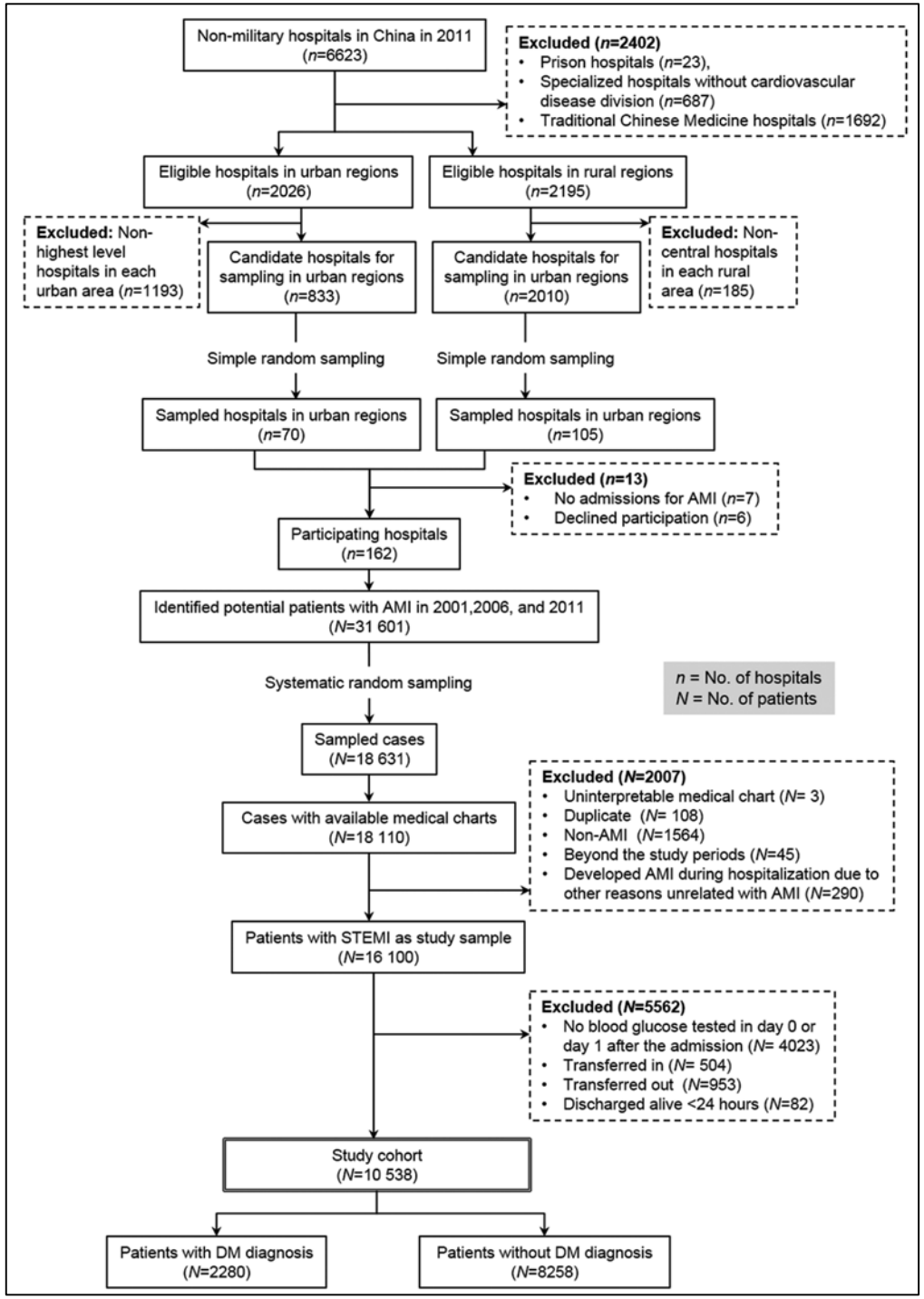

Figure 1: Patient flowchart in a large, nationally representative sample of patients hospitalized with AMI in China in 2001, 2006, and 2011. AMI: Acute myocardial infarction; STEMI: ST-segment elevation myocardial infarction; DM: Diabetes mellitus.

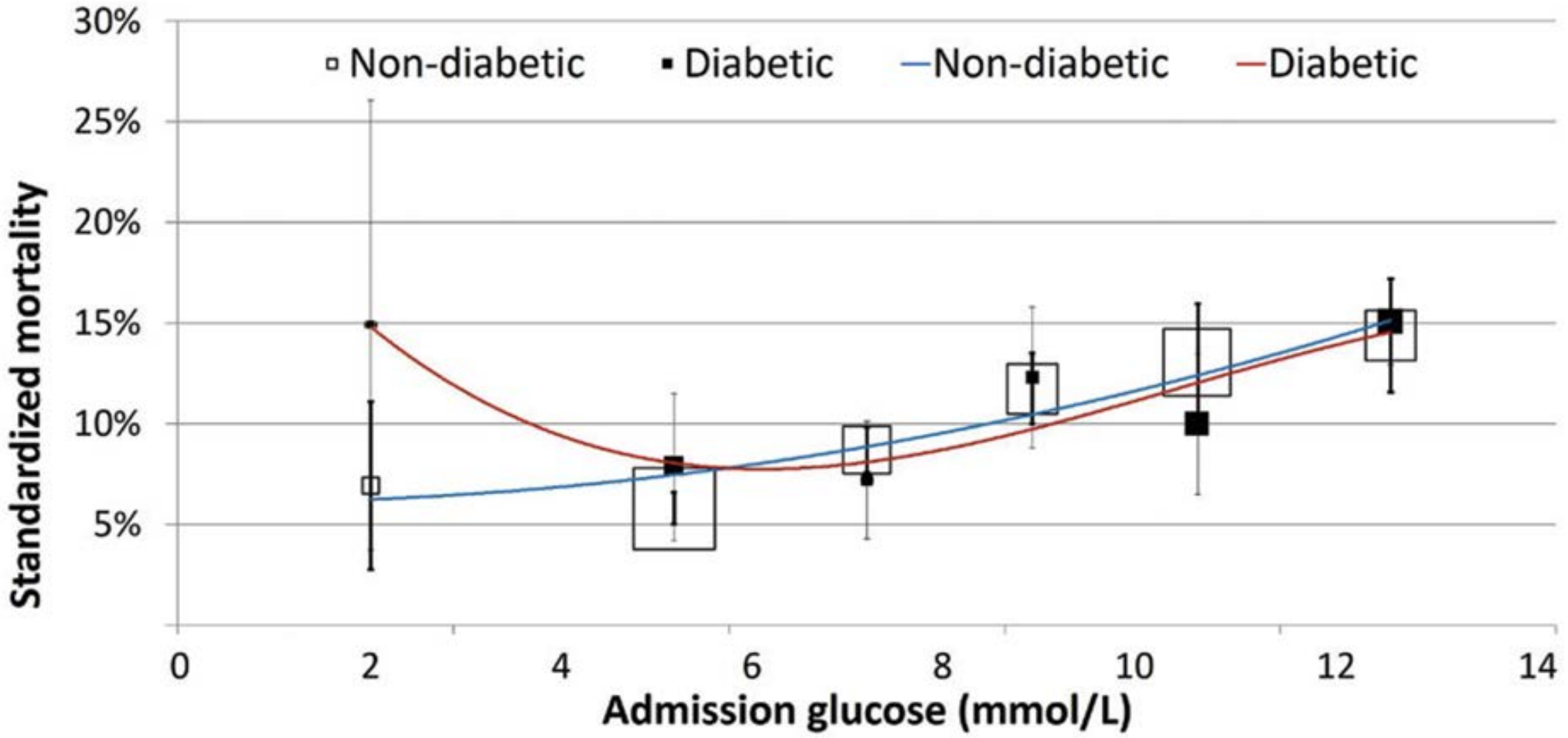

Figure 2: In-hospital mortality associated with admission glucose in diabetic and nondiabetic patients with AMI. Adjusted for patient characteristics, risk factors, medical history, and clinical features at admission. AMI: Acute myocardial infarction.

Table 1: Baseline characteristics of patients with different admission glucose levels in the China PEACE-Retrospective AMI study

Description	Overall (n = 10,538)	Admission glucose (mmol/L)				χ^2	P
		<3.9 (n = 181)	3.9–7.7 (n = 6227)	7.8–11.0 (n = 2423)	≥11.1 (n = 1707)		
Demographics							
Age (years)	67 (57, 75)	67 (57, 74)	66 (56, 74)	67 (58, 75)	68 (58, 75)	48.98	<0.001
Female	3210 (30)	61 (33)	1590 (25)	825 (34)	734 (42)	213.68	<0.001
Medical history/comorbidities							
Diabetes mellitus	2280 (22)	39 (22)	508 (8)	622 (26)	1111 (65)	317.83	<0.001
Current smoker	3646 (34)	49 (27)	2358 (37)	786 (32)	453 (26)	87.94	<0.001
CHD history							
None	8145 (77)	140 (77)	4864 (78)	1881 (77)	1260 (73)	17.43	0.080
CHD, but no MI	1270 (12)	23 (12)	709 (11)	305 (12)	233 (13)		
MI	1123 (10)	18 (9)	654 (10)	237 (9)	214 (12)		
Ischemic stroke history	1136 (10)	15 (8)	604 (10)	292 (12)	225 (13)	23.03	<0.001
Dyslipidemia history	6724 (63)	92 (50)	3938 (63)	1573 (64)	1121 (65)	17.93	<0.001
Hypertension history	5528 (52)	89 (49)	3104 (49)	1343 (55)	992 (58)	48.26	<0.001
Cardiogenic shock	544 (5)	17 (9)	186 (2)	152 (6)	189 (11)	272.02	<0.001
Clinical features							
Time delay to admission (h)	14 (3, 72)	24 (4, 72)	20 (4, 72)	8 (3, 48)	10 (3, 48)	135.98	<0.001
Length of stay (days)	11 (7, 15)	10 (5, 14)	11 (7, 15)	11 (7, 16)	11 (5, 15)	32.47	<0.001
STEMI	8944 (84)	144 (79)	5278 (84)	2081 (85)	1441 (84)	6.26	0.100
SBP at admission (mmHg)	130 (110, 149)	120 (103, 142)	130 (110, 148)	130 (110, 150)	130 (110, 150)	9.61	0.022
RR at admission (beats/min)	20 (18, 20)	20 (19, 22)	20 (18, 20)	20 (18, 21)	20 (18, 22)	64.74	<0.001
HR at admission (beats/min)	78 (66, 90)	78 (64, 92)	76 (65, 88)	78 (66, 90)	82 (70, 100)	187.46	<0.001

Table 1: Continued

Description	Overall (n = 10,538)	Admission glucose (mmol/L)				χ^2	P
		<3.9 (n = 181)	3.9–7.7 (n = 6227)	7.8–11.0 (n = 2423)	≥11.1 (n = 1707)		
eGFR							
<30 ml/min	399 (3)	24 (13)	158 (2)	106 (4)	111 (6)	297.90	<0.001
30–59 ml/min	2067 (19)	39 (21)	1001 (16)	533 (21)	494 (28)		
≥60 ml/min	7269 (68)	97 (53)	4538 (72)	1637 (67)	997 (58)		
Unmeasured	803 (7)	21 (11)	530 (8)	147 (6)	105 (6)		
LVEF							
<40%	615 (5)	8 (4)	320 (5)	169 (6)	118 (6)	35.45	<0.001
≥40%	4789 (45)	62 (34)	2928 (47)	1076 (44)	723 (42)		
Unmeasured	5134 (48)	111 (61)	2979 (47)	1178 (48)	866 (50)		

Data are presented as n (%) or median (inter quartile range). P<0.05, which means distributions of the characteristic in groups of different admission glucose level were not totally the same statistically. PEACE: Patient-centered Evaluative Assessment of Cardiac Events; CHD: Coronary heart disease; MI: Myocardial infarction; STEMI: ST-segment elevation myocardial infarction; DM: Diabetes mellitus; PCI: Percutaneous coronary intervention; SBP: Systolic blood pressure; HR: Heart rate; RR: Respiratory rate; eGFR: Estimated glomerular filtration rate; LVEF: Left ventricular ejection fraction; 1 mmHg = 0.133 kPa.

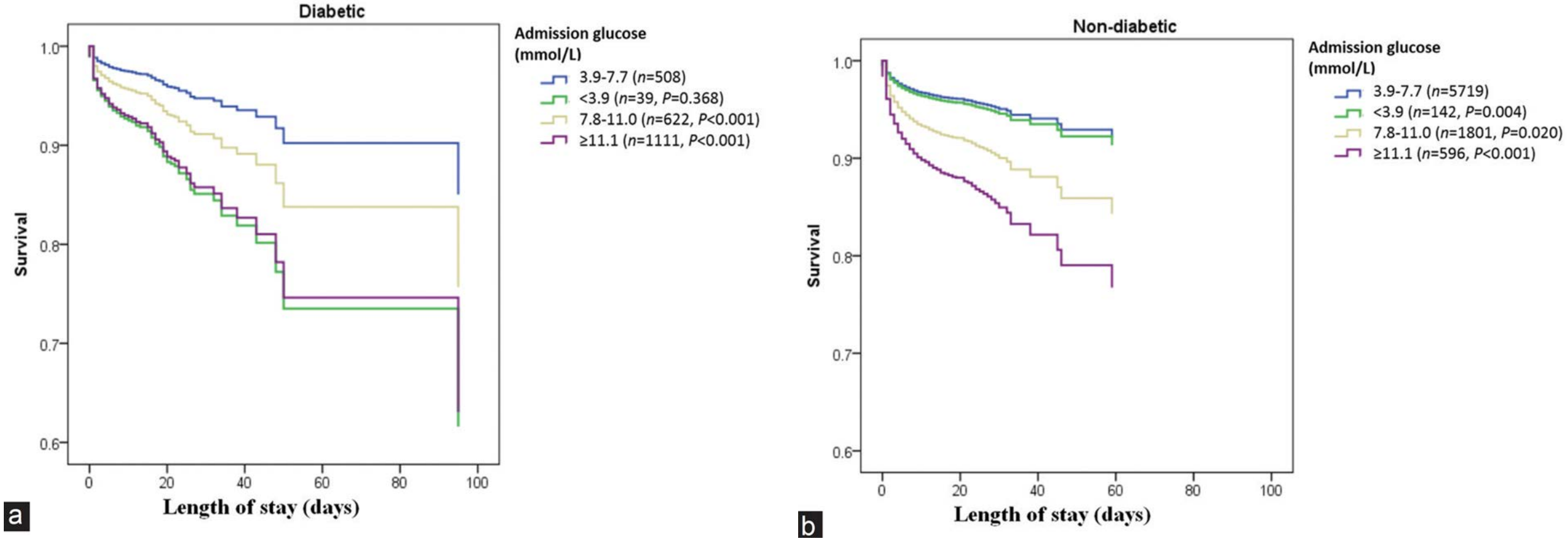

Figure 3: Survival curves by different admission glucose levels in diabetic and nondiabetic patients with AMI.
(a) Compared with the euglycemia group, both the hypoglycemia and hyperglycemia groups were associated with lower survival rates in patients with DM ($P < 0.05$). (b) Only the hyperglycemia groups had lower survival rates in patients without DM ($P < 0.001$). AMI: Acute myocardial infarction; DM: Diabetes mellitus.

Table 2: In-hospital treatments of patients with different admission glucose levels

Description	Overall (n = 10,538)	Admission glucose (mmol/L)				χ^2	P
		<3.9 (n = 181)	3.9–7.7 (n = 6227)	7.8–11.0 (n = 2423)	≥11.1 (n = 1707)		
Fibrinolytic therapy	2035 (19)	30 (16)	1129 (18)	545 (22)	331 (19)	22.19	<0.001
Primary PCI	1243 (11)	12 (6)	659 (10)	361 (14)	211 (12)	36.40	<0.001
Aspirin within 24 h	9220 (87)	152 (83)	5500 (88)	2131 (87)	1437 (84)	23.54	<0.001
Clopidogrel within 24 h	6341 (60)	90 (49)	3725 (59)	1515 (62)	1011 (59)	14.81	0.002
Statin	8378 (79)	126 (69)	4942 (79)	1957 (80)	1353 (79)	13.38	0.004
ACEI/ARB	6860 (65)	110 (60)	4032 (64)	1628 (67)	1090 (63)	7.65	0.054
Beta-blocker within 24h	5054 (47)	86 (47)	3069 (49)	1143 (47)	756 (44)	14.22	0.003
TCM within 24 h	6034 (57)	108 (59)	3606 (57)	1391 (57)	929 (54)	7.14	0.068
TCM injection within 24 h	5530 (52)	99 (54)	3279 (52)	1287 (53)	865 (50)	3.06	0.382
$MgSO_4$	1996 (18)	38 (20)	1147 (18)	497 (21)	314 (18)	5.82	0.120

Data are presented as n (%). P<0.05, which means treatment rates in groups of different admission glucose level were not totally the same statistically. PCI: Percutaneous coronary intervention; ACEI: Angiotensin converting enzyme inhibitor; ARB: Angiotensin receptor blocker; TCM: Traditional Chinese medicine.

Table 3: In-hospital mortality in patients with different admission glucose levels

Admission glucose groups (mmol/L)	Mortality	Unadjusted		Adjusted	
		OR (95% *CI*)	*P*	*OR* (95% *CI*)	*P*
Nondiabetic					
<3.9	14 (9.9)	1.77 (1.01–3.11)	0.047	1.12 (0.60–2.08)	0.727
3.9–7.7	333 (5.8)	1	–	1	–
7.8–11.0	259 (14.4)	2.72 (2.29–3.23)	<0.001	2.34 (1.93–2.84)	<0.001
≥11.1	175 (29.4)	6.72 (5.46–8.28)	<0.001	3.92 (3.04–5.04)	<0.001
Diabetic					
<3.9	11 (28.2)	6.26 (2.84–13.78)	<0.001	3.02 (1.20–7.63)	0.019
3.9–7.7	30 (5.9)	1	–	1	–
7.8–11.0	59 (9.5)	1.67 (1.06–2.64)	0.028	1.75 (1.04–2.92)	0.032
≥11.1	192 (17.3)	3.33 (2.23–4.97)	<0.001	2.97 (1.87–4.71)	<0.001

Data are presented as *n* (%) or median (inter quartile range). $P<0.05$, which means mortality in this group was different statistically with in the euglycemic group (3.9–7.7mmol/L). *OR*: Odds ratio; *CI*: Confidence interval; –: No data.

Conclusions

- Hyperglycemia at presentation is common among patients with AMI in China and associated with a similar increased risk of death in both diabetics and nondiabetics.
- However, hypoglycemia increased risk of death only in diabetic patients.
- Further study is needed to elucidate the reasons for this pattern in China.