Patterns of Use of Angiotensin-Converting Enzyme Inhibitors/Angiotensin Receptor Blockers Among Patients With Acute Myocardial Infarction in China From 2001 to 2011: China PEACE-Retrospective AMI Study

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Background—Chinese and U.S. guidelines recommend angiotensin-converting enzyme inhibitors (ACEIs)/angiotensin receptor blockers (ARBs) for all patients with acute myocardial infarction (AMI) in the absence of contraindications as either a Class I or Class IIa recommendation. Little is known about the use and trends of ACEI/ARB therapy in China over the past decade.

Methods and Results—Using nationally representative data from the China Patient-centered Evaluative Assessment of Cardiac Events Retrospective Study of Acute Myocardial Infarction (China PEACE-Retrospective AMI Study), we assessed use of ACEI/ARB therapy in 2001, 2006, and 2011, overall and across geographic regions and strata of estimated mortality risk, and predictors of ACEI/ARB therapy, among patients with Class I indication by Chinese guidelines. The weighted rate of ACEI/ARB therapy increased from 62.0% in 2001 to 71.4% in 2006, decreasing to 67.6% in 2011. Use was low across all 5 geographic regions. By strata of estimated mortality risk, in 2001, rates of therapy increased with increasing risk; however, by 2011, this reversed and those at higher risk were less likely to be treated (70.7% in lowest-risk quintile vs. 63.5% in the highest-risk quintile; $P<0.001$).

Conclusion—One third of Chinese AMI patients with Class I indications do not receive ACEI/ARB therapy during hospitalization, with little improvement in rates over time. Patients at higher mortality risk in 2011 were less likely to be treated, highlighting important opportunities to optimize the use of this cost-effective therapy.

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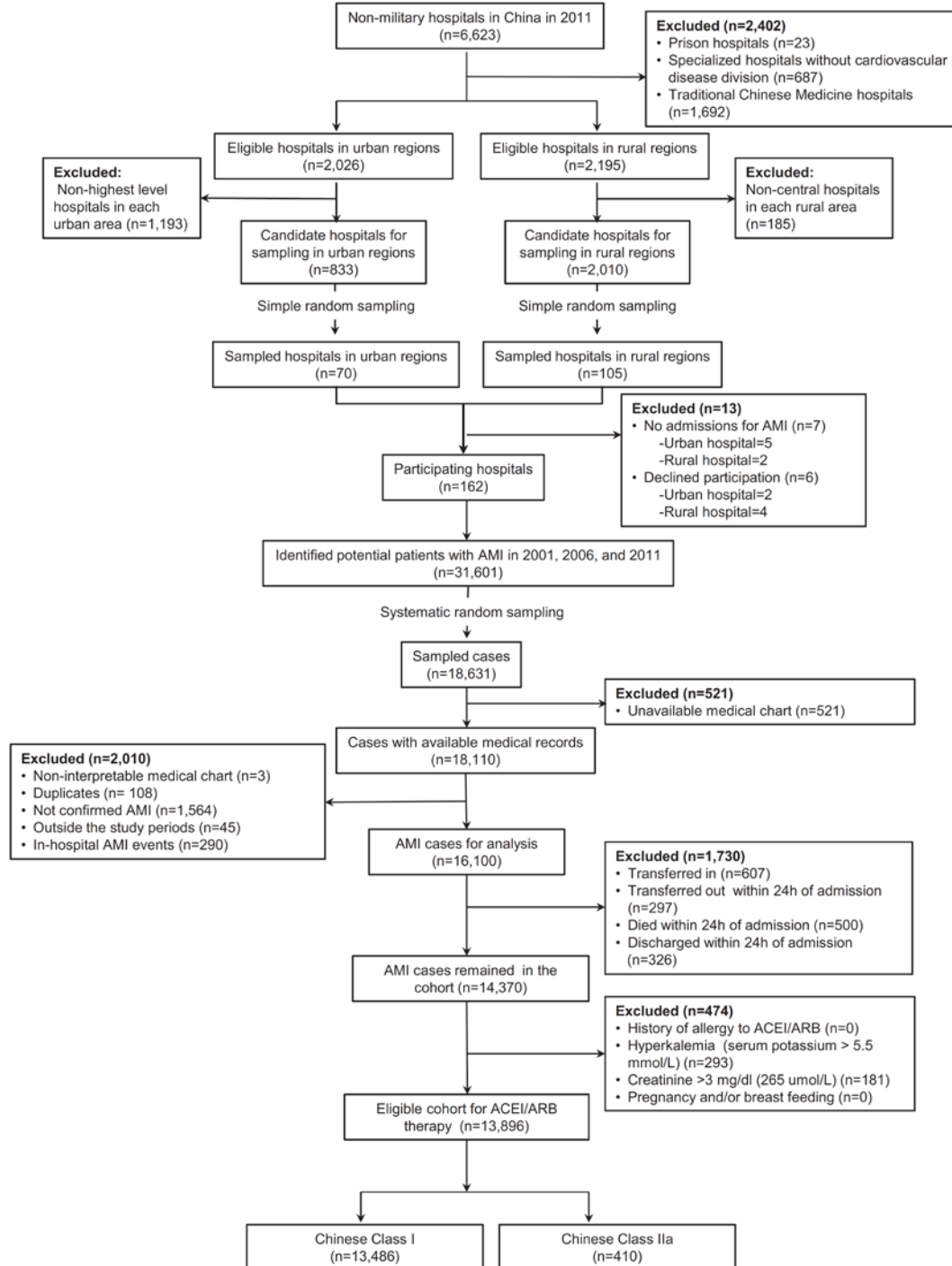
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Abstract

Background- Chinese and U.S. guidelines recommend angiotensin-converting enzyme inhibitors (ACEIs)/angiotensin receptor blockers (ARBs) for all patients with acute myocardial infarction (AMI) in the absence of contraindications as either a Class I or Class IIa recommendation. Little is known about the use and trends of ACEI/ARB therapy in China over the past decade.

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Conclusion- One third of Chinese AMI patients with Class I indications do not receive ACEI/ARB therapy during hospitalization, with little improvement in rates over time. Patients at higher mortality risk in 2011 were less likely to be treated, highlighting important opportunities to optimize the use of this cost-effective therapy.

Figure 1. Study sample profile. ACEI indicates angiotensin-converting enzyme inhibitor; AMI, acute myocardial infarction; ARB, angiotensin receptor blocker.
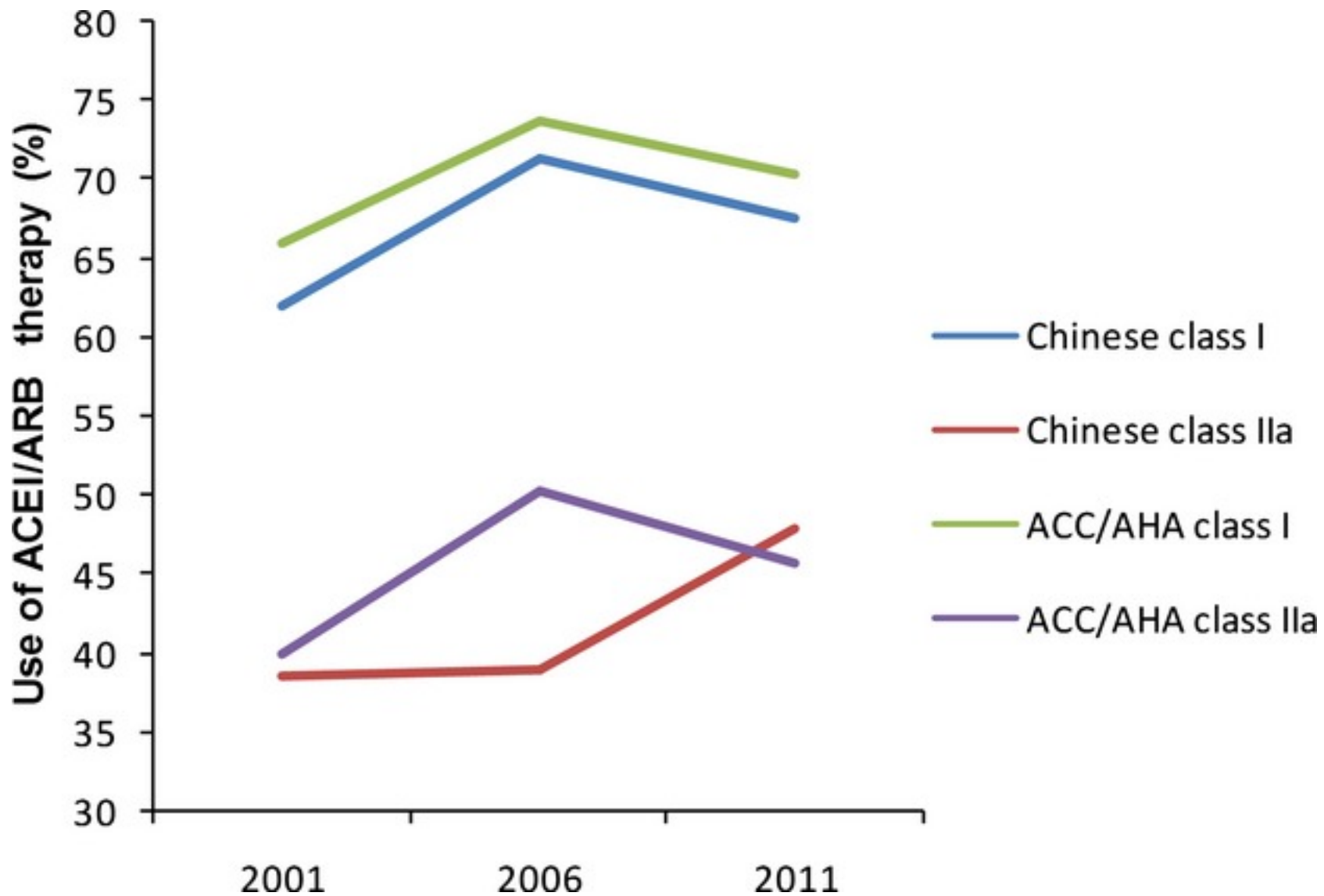
Figure 2. Temporal trends in ACEI/ARB therapy by Chinese Class I and IIa, and ACC/AHA Class I and IIa. ACC/AHA indicates American College of Cardiology/American Heart Association; ACEI, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker.

Table 1. Patient and Hospital Characteristics Among Patients With a Chinese Class I Indication for ACEI/ARB, Overall and Stratified by Receipt of ACEI/ARB Therapy During Hospitalization

Characteristics	Total (%) (N=13 486)	Received ACEI/ARB (%) (N=9008)	Did not Receive ACEI/ARB (%) (N=4478)	P Value
Demographic				
Age, y				0.16
<55	22.2	21.6	23.4	
55 to 64	23.7	23.8	23.3	
65 to 74	30.1	30.4	29.6	
≥75	24.0	24.1	23.7	
Gender				0.30
Male	69.9	70.2	69.3	
Female	30.1	29.8	30.7	
Cardiovascular risk factors				
Hypertension	52.4	60.4	36.4	<0.001
Diabetes	20.6	22.5	16.9	<0.001
Current smoker	34.9	35.3	34.1	0.15
Medical history				
Stroke	11.5	11.9	10.8	0.07
Chronic renal insufficiency	1.9	1.9	1.8	0.68
Coronary heart disease	22.6	23.5	20.6	<0.001
Myocardial infarction	10.8	11.4	9.7	0.003

Table 1. Continued

Characteristics	Total (%) (N=13 486)	Received ACEI/ARB (%) (N=9008)	Did not Receive ACEI/ARB (%) (N=4478)	P Value
Clinical characteristics during hospitalization				
AMI type				<0.001
Anterior STEMI	42.4	44.6	37.9	
Non-anterior STEMI	45.8	42.4	52.7	
NSTEMI	11.8	13.0	9.4	
Cardiac arrest	2.8	2.6	3.1	0.09
Cardiogenic shock	6.2	5.0	8.6	<0.001
Heart failure	34.6	37.3	29.0	<0.001
Atrial fibrillation	9.4	9.5	9.3	0.63
SBP, mm Hg				<0.001
<90	4.1	2.4	7.4	
90 to 139	58.5	53.8	68.2	
≥140	37.4	43.8	24.4	
Heart rate, beats/min				<0.001
<60	12.3	10.8	15.3	
60 to 90	65.8	66.3	64.7	
>90	22.0	22.9	20.1	
eGFR, mL/min per 1.73 m^2				<0.001
<60	16.6	14.3	21.1	
60 to 89	26.1	23.7	31.1	
≥90	24.8	22.7	29.0	
Unmeasured	32.5	39.4	18.8	

Table 1. Continued

Characteristics	Total (%) (N=13 486)	Received ACEI/ARB (%) (N=9008)	Did not Receive ACEI/ARB (%) (N=4478)	P Value
LVEF value				<0.001
≤0.40	7.0	7.7	5.5	
>0.40	41.6	46.0	32.7	
Unmeasured	51.4	46.3	61.7	
Economic-geographic region				
Eastern	59.2	58.7	60.2	0.10
Central	21.2	21.2	21.2	
Western	19.6	20.1	18.6	
Rural/urban				
Rural	38.8	38.1	40.2	0.02
Urban	61.2	61.9	59.8	
Hospital characteristics*				
Teaching	80.3	82.3	76.3	<0.001
PCI-capable	60.8	63.4	55.5	<0.001
Year				
2001	15.1	13.9	17.7	<0.001
2006	28.5	29.9	25.9	
2011	56.3	56.3	56.4	

ACEI indicates angiotensin-converting enzyme inhibitor; AMI, acute myocardial infarction; ARB, angiotensin receptor blocker; eGFR, estimated glomerular filtration rate; LVEF, left ventricular ejection fraction; NSTEMI, non-ST-segment elevation myocardial infarction; PCI, percutaneous coronary intervention; SBP, systolic blood pressure; STEMI, ST-segment elevation myocardial infarction.

*The number (N) reflects the number of patients who were admitted to hospitals with this characteristic.

Table 2. Baseline Demographic and Clinical Characteristics Between Chinese Class I Patients and Patients With Length of Stay Less Than 24 Hours

Characteristics	Chinese Class I Patients (%) (N=13 486)	Patients With Length of Stay <24 Hours (%) (N=1123)	P Value
Demographics			
Age, y			<0.001
<55	22.2	16.7	
55 to 64	23.7	19.2	
65 to 74	30.1	31.2	
≥75	24.0	32.9	
Gender			<0.001
Male	69.9	60.6	
Female	30.1	39.4	
Cardiovascular risk factors			
Hypertension	52.4	40.7	<0.001
Diabetes	20.6	17.7	0.02
Current smoker	34.9	13.2	<0.001
Medical history			
Stroke	11.5	11.4	0.92
Chronic renal insufficiency	1.9	2.7	0.05
Coronary heart disease	22.6	19.2	0.01

Table 2. Continued

Characteristics	Chinese Class I Patients (%) (N=13 486)	Patients With Length of Stay <24 Hours (%) (N=1123)	P Value
Myocardial infarction	10.8	8.3	0.008
Clinical characteristics during hospitalization			
AMI type			0.001
Anterior STEMI	42.4	47.8	
Non-anterior STEMI	45.8	40.5	
NSTEMI	11.8	11.7	
Cardiac arrest	2.8	18.9	<0.001
Cardiogenic shock	6.2	35.4	<0.001
Heart failure	34.6	37.4	0.06
Atrial fibrillation	9.4	9.7	0.77
SBP, mm Hg			<0.001
<90	4.1	24.6	
90 to 139	58.5	52.2	
≥140	37.4	23.2	
Heart rate, beats/min			<0.001
<60	12.3	17.7	
60 to 90	65.8	47.8	
>90	22.0	34.5	
eGFR, mL/min per 1.73 m^2			<0.001
<60	16.6	28.6	
60 to 89	26.1	18.4	
≥90	24.8	11.1	
Unmeasured	32.5	41.9	

Table 2. Continued

Characteristics	Chinese Class I Patients (%) (N=13 486)	Patients With Length of Stay <24 Hours (%) (N=1123)	P Value
LVEF value			<0.001
≤0.40	7.0	1.5	
>0.40	41.6	2.5	
Unmeasured	51.4	96.0	
Economic-geographic region			
Eastern	59.2	55.8	0.03
Central	21.2	24.3	
Western	19.6	19.9	
Rural/urban			
Rural	38.8	53.8	<0.001
Urban	61.2	46.2	
Hospital characteristics*			
Teaching	80.3	72.6	<0.001
PCI-capable	60.8	48.1	<0.001
Year			
2001	15.1	9.0	<0.001
2006	28.5	27.0	
2011	56.3	64.0	

AMI indicates acute myocardial infarction; eGFR, estimated glomerular filtration rate; LVEF, left ventricular ejection fraction; NSTEMI, non-ST-segment elevation myocardial infarction; PCI, percutaneous coronary intervention; SBP, systolic blood pressure; STEMI, ST-segment elevation myocardial infarction.

*The number (N) reflects the number of patients who were admitted to hospitals with this characteristic.

**Table 3.** The Proportion of Patients With Length of Stay Less Than 24 Hours Receiving ACEI/ARB Therapy

Patients	Died (N=500)	Transferred Out (N=297)	Discharged (N=326)
ACEI/ARB	20.8%	32.0%	27.6%

ACEI indicates angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker.

Table 4. The Weighted Proportion of ACEI/ARB Therapy in Patients With Creatinine <1.5 and ≤3.0 mg/dL by Year by Chinese Class I and Class IIa

| Cr Value	Patients	Received ACEI/ARB, % (95% CI)			P for Trend
		2001	2006	2011	
Cr<1.5	Chinese Class I	62.4 (60.2 to 64.6)	72.5 (71.0 to 74.0)	68.5 (67.4 to 69.6)	<0.01
	Chinese Class IIa	36.5 (23.0 to 50.0)	37.4 (26.2 to 48.6)	48.1 (42.1 to 54.1)	0.06
Cr≤3.0	Chinese Class I	62.0 (59.9 to 64.1)	71.4 (70.0 to 72.8)	67.6 (65.5 to 68.6)	0.01
	Chinese Class IIa	38.6 (32.0 to 45.3)	38.9 (33.3 to 44.4)	47.9 (44.9 to 50.9)	0.1

ACEI indicates angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; Cr, creatinine.
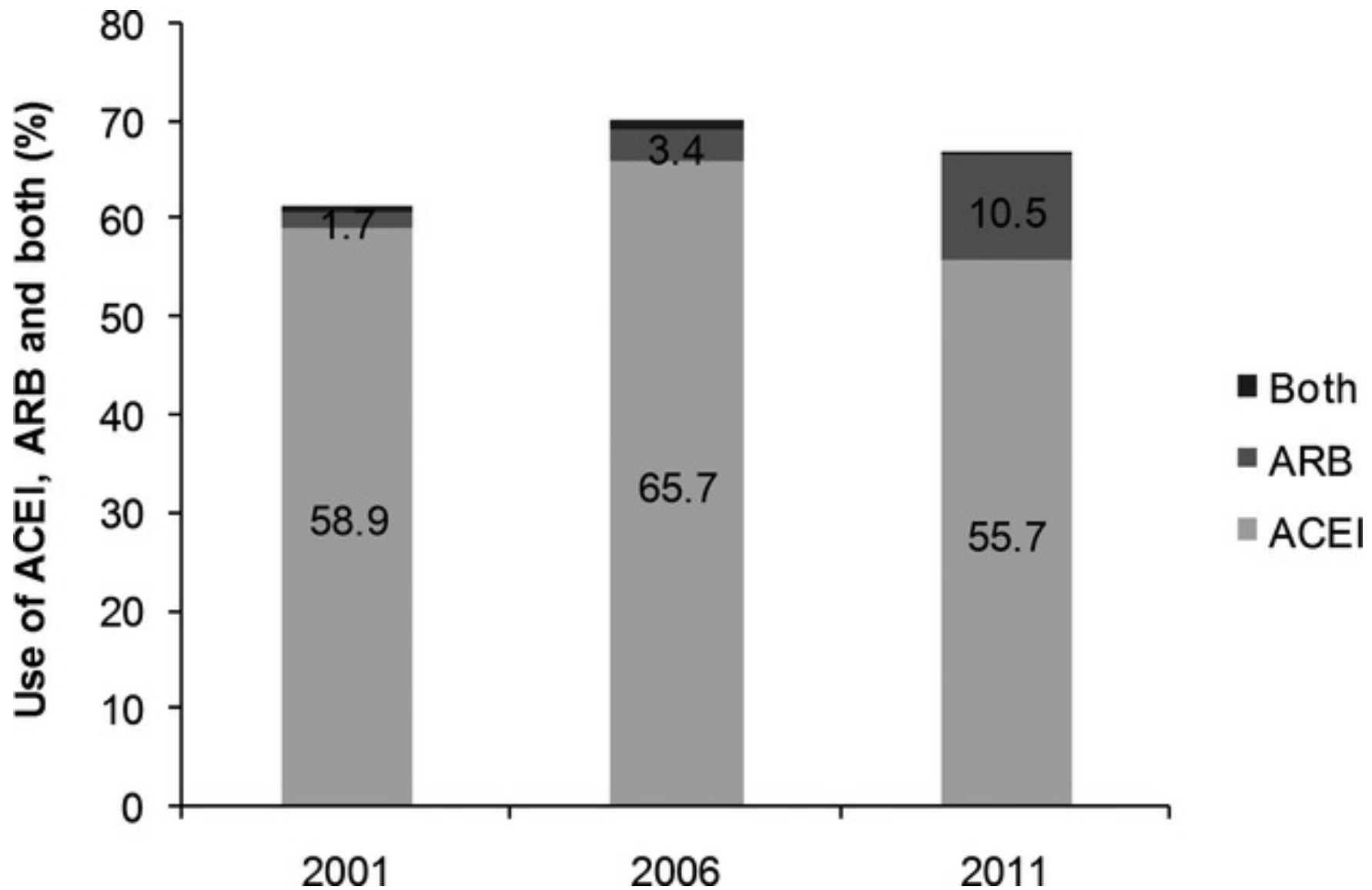
Figure 3. Use of ACEI, ARB, and both ACEI/ARB among Chinese Class I patients by year. ACEI indicates angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker.
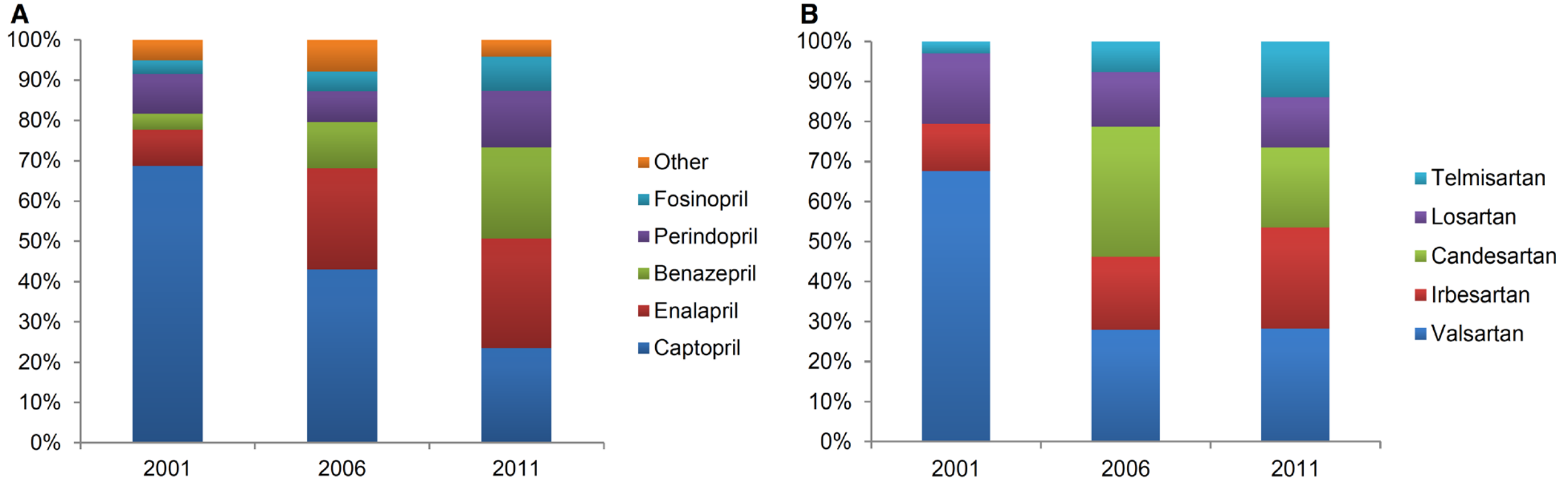
Figure 4. A, ACEI prescription among eligible patients by year. B, ARB prescription among eligible patients by year. ACEI indicates angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker.
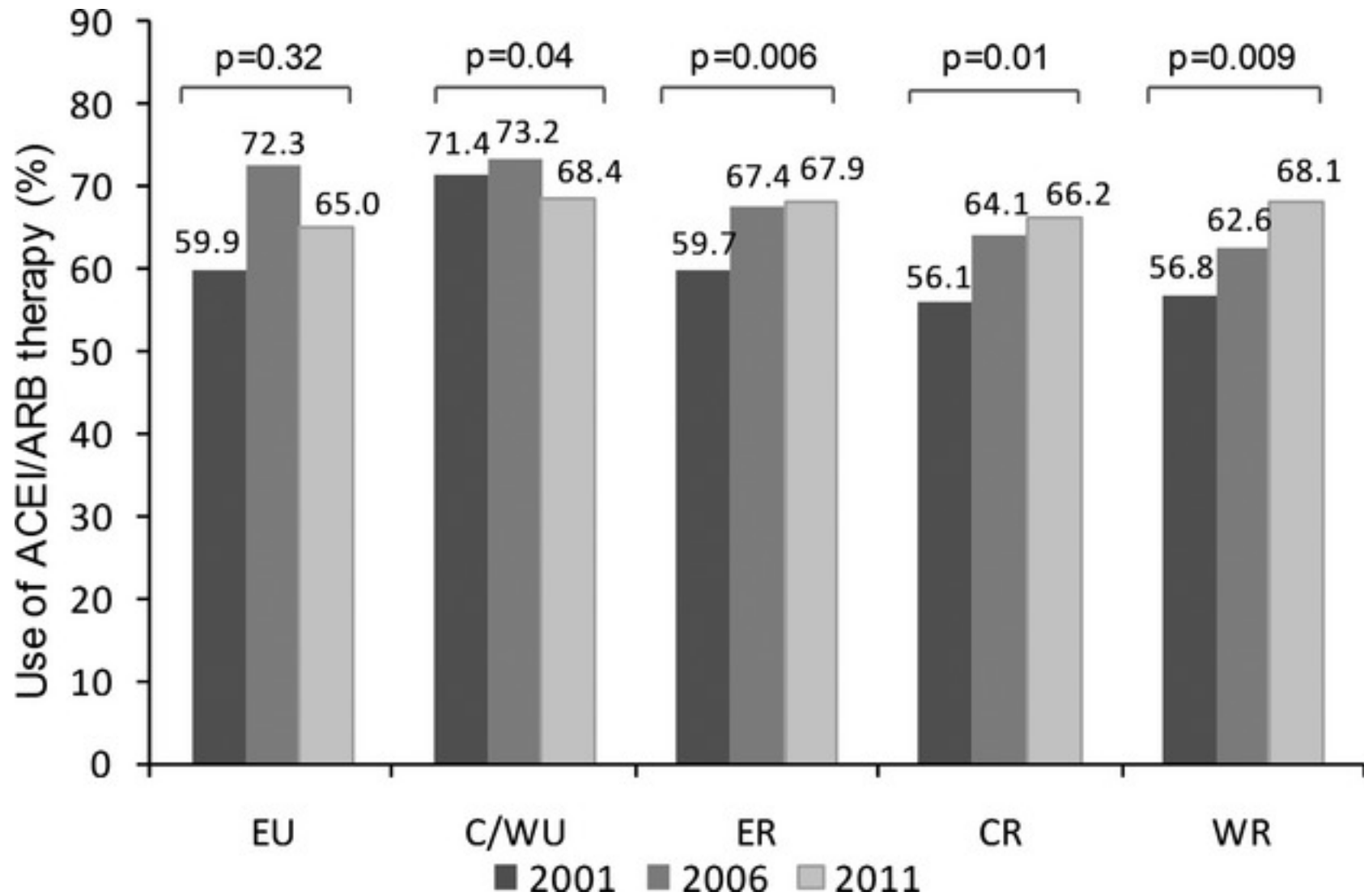
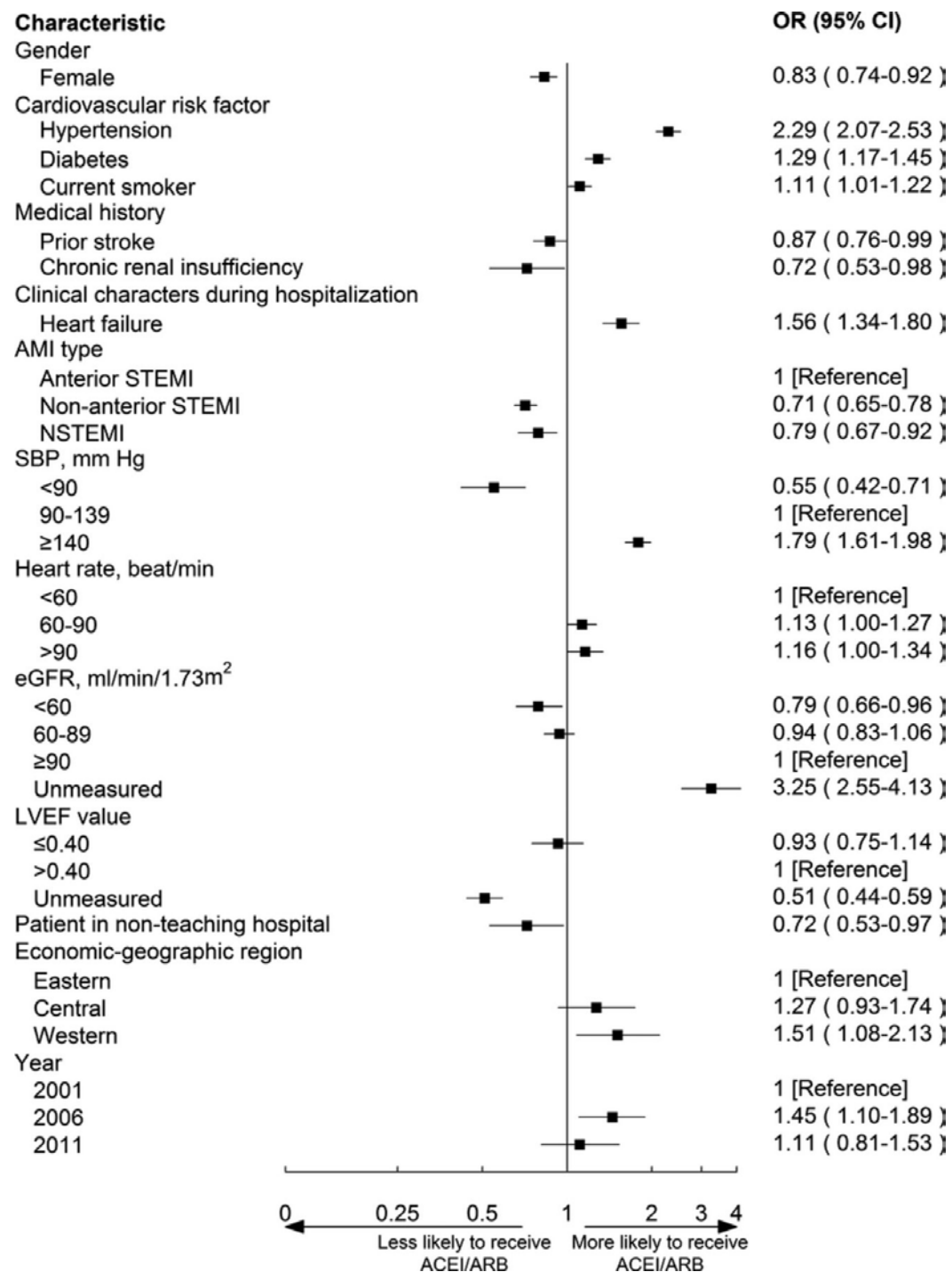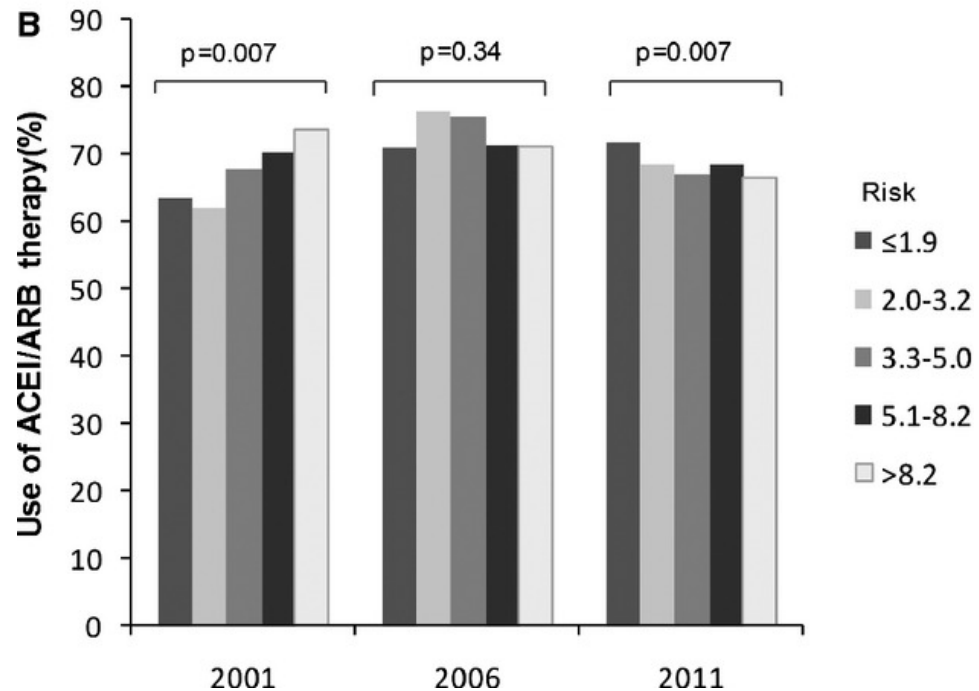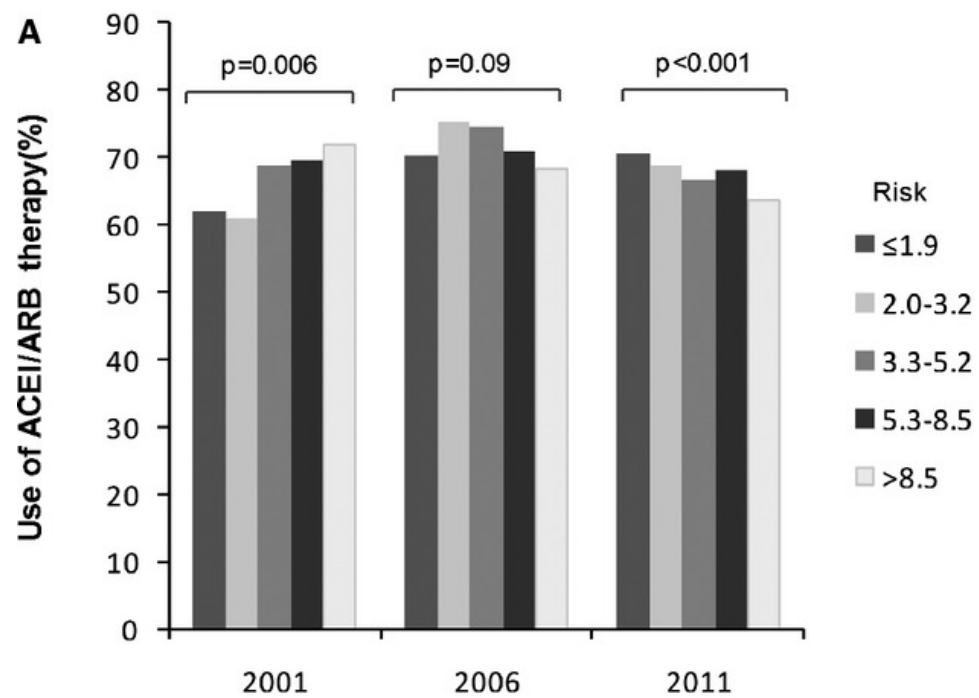**Figure 5.** Regional trends in ACEI/ARB use among Chinese Class I patients by year. ACEI indicates angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; C/WU, central/western-urban; CR, central-rural; ER, eastern-rural; EU, eastern-urban; WR, western-rural.

Characteristic	OR (95% CI)
Gender	
Female	0.83 (0.74-0.92)
Cardiovascular risk factor	
Hypertension	2.29 (2.07-2.53)
Diabetes	1.29 (1.17-1.45)
Current smoker	1.11 (1.01-1.22)
Medical history	
Prior stroke	0.87 (0.76-0.99)
Chronic renal insufficiency	0.72 (0.53-0.98)
Clinical characters during hospitalization	
Heart failure	1.56 (1.34-1.80)
AMI type	
Anterior STEMI	1 [Reference]
Non-anterior STEMI	0.71 (0.65-0.78)
NSTEMI	0.79 (0.67-0.92)
SBP, mm Hg	
<90	0.55 (0.42-0.71)
90-139	1 [Reference]
≥140	1.79 (1.61-1.98)
Heart rate, beat/min	
<60	1 [Reference]
60-90	1.13 (1.00-1.27)
>90	1.16 (1.00-1.34)
eGFR, ml/min/1.73m^2	
<60	0.79 (0.66-0.96)
60-89	0.94 (0.83-1.06)
≥90	1 [Reference]
Unmeasured	3.25 (2.55-4.13)
LVEF value	
≤0.40	0.93 (0.75-1.14)
>0.40	1 [Reference]
Unmeasured	0.51 (0.44-0.59)
Patient in non-teaching hospital	0.72 (0.53-0.97)
Economic-geographic region	
Eastern	1 [Reference]
Central	1.27 (0.93-1.74)
Western	1.51 (1.08-2.13)
Year	
2001	1 [Reference]
2006	1.45 (1.10-1.89)
2011	1.11 (0.81-1.53)

0   0.25   0.5   1   2   3 4

Less likely to receive ACEI/ARB ← → More likely to receive ACEI/ARB

Figure 6. Factors associated with ACEI/ARB use among Chinese Class I patients in multivariable analysis. Variables associated with ACEI/ARB use are shown along the vertical axis. The strength of effect is shown along the horizontal axis with the vertical line demarcating an odds ratio (OR) of 1 (i.e., no association); estimates to the right (i.e., >1) are associated with a greater likelihood of ACEI/ARB use, whereas those to the left (i.e., <1) indicate a reduced likelihood of ACEI/ARB use. Each dot represents the point estimate of the effect of that variable in the model, whereas the line shows the 95% confidence interval (CI). C-statistic=0.75. ACEI indicates angiotensin-converting enzyme inhibitor; AMI, acute myocardial infarction; ARB, angiotensin receptor blocker; eGFR, estimated glomerular filtration rate; LVEF, left ventricular ejection fraction; NSTEMI, non-ST-segment elevation myocardial infarction; SBP, systolic blood pressure; STEMI, ST-segment elevation myocardial infarction.

Figure 7. A, ACEI/ARB use among Chinese Class I patients by year stratified by estimated in-hospital mortality risk. P for trend. P for year x mortality risk interaction <0.001. C-statistic=0.77. B, ACEI/ARB use among Chinese Class I patients after excluding BP <90 mmHg by year stratified by estimated in-hospital mortality risk. P for trend. P for year x mortality risk interaction <0.001. C-statistic= 0.76. ACEI indicates angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; BP, blood pressure.

Conclusion

- In this nationally representative study of patients hospitalized with AMI in China, we found underutilization of ACEI/ARB therapy, which extends across regions, and rates of use have not improved appreciably over the past decade.
- Moreover, with time, a risk treatment paradox has emerged, wherein there is considerable underuse of ACEI/ARB among subgroups at the highest risk for mortality.
- These findings identify important opportunities for improvement as the Chinese health-care system reengineers itself to deliver high-quality care to the rising number of people with AMI.
- These data can serve as a baseline against which future improvements can be measured.