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[#]The participating hospitals of the NRCIMH Program are listed in Table S1 in the Supplement.

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Running head: PCI performance in ACS

ABSTRACT

Objectives Interventional treatment of patients with ACS (Acute Coronary Syndrome) is surging dramatically in China in recent years, whereas nationwide assessments of the quality of PCI (Percutaneous Coronary Intervention) procedural performance and outcomes are scarce. We aimed to provide an updated and real-world overview of the performance of PCI in ACS patients since 2011 in China after the China PEACE study from 2001 to 2011.

Methods In this cross-sectional study, data were extracted from the NRCIMH (National Registry of Cardiovascular Intervention in Military Hospitals) database to create a national sample of 144 659 ACS patients undergoing PCI at 117 military hospitals in all regions of China from calendar year 2011 to 2014. Patient characteristics, procedural performance, PCI outcomes and adverse events and temporal changes were analyzed.

Results During 2011 to 2014, ACS patients undergoing PCI increased dramatically. Small numbers of high-volume hospitals performed the majority of PCI procedures. However, only half of these patients were adequately covered and proportions for the use of assisted devices and novel medications were relatively small. Radial artery access was still increasing with time. Primary PCIs were performed on 45.4% STEMI patients with PCI procedures. 3.8% lesion vessels involve left main artery. Implanted stents, the overall complications and in-hospital mortality were decreasing remarkably.

Conclusions Although interventional resources were limited with great regional disparities in China, notable improvements in the quality of care were found during the study years. Our findings can serve as an indispensable supplement to a more comprehensive understanding of the practice of contemporary cardiac intervention in China.

Key Words: Acute Coronary Syndrome; Percutaneous Coronary Intervention; Trending; Quality of

care.

Strengths and limitations of this study

This is the first nationwide study of the performance of PCI in ACS patients covering all geographic regions of mainland China.

The assessment was based on real world registry data with sequential enrollment from calendar year 2011 to 2014.

PCI outcomes were based on in-hospital data and no follow-up were done to evaluate the long term improvement of ACS patients undergoing PCI.

Although all PCI-capable military hospitals participated in this program, patient outcomes might be differentially affected by interventionist in hospitals with various volumes of PCI procedures each year, thus may confound the overall results.

INTRODUCTION

In China, military hospitals play an indispensible role in providing health care service largely to civilian patients in peacetime.[1-5] The drastic increase of acute coronary syndrome (ACS) in China has also catalyzed the growth of percutaneous coronary intervention (PCI) in quantity.[6] However, whether the rapid growth of PCI volume has translated into good quality of care for these ACS patients treated in military hospitals remains unclear. The lack of a nationwide comprehensive assessment of interventional practice hampered the improvement of health care provided to these patients. To standardize and monitor the quality of care for patients undergoing PCI procedures, we conducted the NRCIMH (National Registry of Cardiovascular Intervention in Military Hospitals) study.[7-9] During calendar years 2011 to 2014, 117 PCI-capable military hospitals in all seven geographical regions of China and 11 241 ACS patients undergoing PCI procedures were included in this study. Patient

characteristics, quality of procedural performance, PCI outcomes, and in-hospital adverse events and their temporal changes were analyzed over time.

Methods

This study was a cross-sectional study using a registered dataset. The original data for this study was extracted from the National Registry of Cardiovascular Intervention in Military Hospitals (NRCIMH, web access via http://www.xxgjr.com). This database collected social-demographic, medical and interventional data of patients who had cardiovascular disease and underwent cardiac interventions since October 2010 in all military hospitals nationwide that are qualified to perform cardiac catheterization and PCI.[7-9] Patient demographics, clinical characteristics, and treatment patterns during hospitalization were collected by physicians who were in charge of the patient, and coronary catheterization or PCI related information were collected by the responsible operator or technical assistant. Patient data were censored and uploaded into the database by designated medical personnel in each individual hospital. The majority of patients had coronary artery disease and underwent PCI. This study was approved by the ethics committee of the General Hospital of Shenyang Military Region. The requirement of informed consent was waived due to the nature of the retrospective study. All participating hospitals accepted the ethics committee approval.

ACS Patients (with definite diagnosis of either STEMI, NSTEMI, or unstable angina pectoris) undergoing interventional procedures in all 117 military hospitals (Table S1) from January 1, 2011 to December 31, 2014 were included in this study. Patients with missing data were excluded in various categorical analyses.

We collected data from a unified registry form abstracted from the original Database systems,

including baseline characteristics (diagnosis, patient category, age, gender, ethnicity, region of admission hospital, medical history), perioperative characteristics (primary PCI composition, access artery, contrast type, antiplatelet and anticoagulation medications, assisted devices), PCI outcomes (stenosis pre-PCI, lesion category, lesion vessel, target vessel), and adverse outcomes including complication and death both during PCI and post-PCI. For the convenience of calculation, anomalous artery, intermediate artery and vessel graft lesion as well as interventions done in these vessels were all merged into the individual categories. In addition, due to a systematic revision of the registry form since 2013, partial data were analyzed and summarized in the supplement, including location and Killip classification of MI history, assisted device used during 2011-2013, information regarding medical coverage, thrombolysis of STEMI patient, PCI outcomes, and stent manufacturer during 2013-2014. The sum for each measured category was listed in the column of each category unless otherwise specified.

We used percentages to describe categorical variables and median with interquartile ranges (IQRs) to describe continuous variables unless otherwise specified. χ^2 trend tests were used to examine trends across different study years for categorical variables. For the comparison of data between 2013 and 2014, χ^2 tests were used for categorical variables and Mann Whitney tests for continuous variables with non-normal distribution. All comparisons were 2-sided, with statistical significance defined as $P< 0.05$. Statistical analyses were performed using GraphPad Prism, version 6.01.

Patient and Public Involvement Patients and public were not involved in this study.

Results

A total of 144 659 ACS patients undergoing PCI in 117 military hospitals were recruited into this study from 2011 to 2014, located in all 7 geographic regions of mainland China, including North China

(n = 25), Northwest (n = 14), Northeast (n = 10), East China (n = 29), Southwest (n = 14), Central China (n = 12), and South China (n = 13). Of these, 82 hospitals provided 140 374 cases (97.0%) across all the study years (Table S1). In brief, only 20 (17.1%) hospitals performed more than 400 PCIs on ACS patients annually (Figure 1A), and these hospitals performed 71.9% PCIs (104 026 cases) during 2011-2014 (Figure 1B). Geographically, although the total number of hospitals in Northern China (North China, Northwest, Northeast regions) was less than that in Southern China (South China, East China, Central China, and Southwest regions), there were more military hospitals in Northern China performed PCI procedures > 400 cases per year than those in Southern China (Figure 1C), and northern military hospitals performed the majority of PCIs during the study years (66.5%) (Figure 1D).

Generally, the number of ACS patient undergoing PCI has increased by 27.8%, while the proportions of most comorbidities of these patients had concordant decrease over time. Hospitals in northern China (North China, Northwest, and Northeast) performed the majority of PCIs, with most patients being civilian and with Han ethnicity. There were significant increases in the proportions of patients diagnosed as UAP, of civilian identity, male gender, treated in hospitals in Northeast, East and South China, and significant decreases in the proportions of patients diagnosed as STEMI, treated in hospitals in North China, Northwest and Central China (Table 1). During 2013-2014, only half of these patients were covered by urban resident medical service (53.4% to 53.6%) (Table S2).

Table 1. Baseline characteristics of ACS patients undergoing PCI during 2011-2014

	2011		2012		2013		2014		*P* value
	n	%	n	%	n	%	n	%	for trend
ACS	30800		34974		39524		39361		
UAP	22038	71.6	24847	71.0	28727	72.7	28508	72.4	< .0001
STEMI	6514	21.1	7302	20.9	7889	20.0	7856	20.0	< .0001
NSTEMI	2248	7.3	2825	8.1	2908	7.4	2997	7.6	.87
Age, years	30651		34872		39466		39351		
18-24	12	0.0	8	0.0	16	0.0	15	0.0	.70
25-34	177	0.6	223	0.6	246	0.6	243	0.6	.62

35-44	1597	5.2	1930	5.5	2149	5.4	2187	5.6	.09
45-54	5849	19.1	6663	19.1	7283	18.5	7507	19.1	.52
55-64	10291	33.6	11990	34.4	13888	35.2	13381	34.0	.11
65-74	8615	28.1	9510	27.3	10650	27.0	10832	27.5	.09
75-84	3850	12.6	4227	12.1	4884	12.4	4800	12.2	.33
>84	260	0.8	321	0.9	350	0.9	386	1.0	.11
Gender	30155		34191		39189		39336		
Male	22017	73.0	25423	74.4	29104	74.3	29193	74.2	< .01
Female	8138	27.0	8768	25.6	10085	25.7	10143	25.8	
Ethnicity	30800		34974		39524		39361		
Han	30589	99.3	34691	99.2	38974	98.6	38620	98.1	< .0001
Others	211	0.7	283	0.8	550	1.4	741	1.9	
Region of hospital	30783		34970		39524		39361		
North China	9156	29.7	9631	27.5	9914	25.1	11086	28.2	< .0001
Northwest	7632	24.8	7939	22.7	9728	24.6	7821	19.9	< .0001
Northeast	3924	12.7	5347	15.3	6691	16.9	7284	18.5	< .0001
East China	3742	12.2	4630	13.2	5053	12.8	5241	13.3	< .001
Southwest	3515	11.4	4346	12.4	4877	12.3	4549	11.6	.96
Central China	1977	6.4	1928	5.5	1910	4.8	1944	4.9	< .0001
South China	837	2.7	1149	3.3	1351	3.4	1436	3.6	< .0001
Comorbidities	30800		34974		39524		39361		
Hypertension	17600	57.1	19942	57.0	21260	53.8	21701	55.1	< .0001
Hyperlipidemia	6844	22.2	7774	22.2	7420	18.8	7330	18.6	< .0001
Diabetes Mellitus	6829	22.2	7817	22.4	8394	21.2	8819	22.4	.75
COPD	541	1.8	448	1.3	478	1.2	447	1.1	< .0001
Current smoking	9093	29.5	10838	31.0	11467	29.0	10568	26.8	< .0001
Heart failure*	1378	4.5	1373	3.9	1331	3.4	1122	2.9	< .0001
Renal failure*	277	0.9	297	0.8	259	0.7	276	0.7	< .001
Under dialysis*	34	0.1	52	0.1	45	0.1	45	0.1	.71
Prior MI	7560	24.5	7828	22.4	7928	20.1	5648	14.3	< .0001
Prior CVD	2014	6.5	1912	5.5	1990	5.0	2018	5.1	< .0001
Prior PVD	457	1.5	430	1.2	489	1.2	515	1.3	.09
Prior PCI	5702	18.5	6125	17.5	6467	16.4	5973	15.2	< .0001
Prior CVS	1077	3.5	1192	3.4	563	1.4	14	0.0	< .0001
Prior CABG	936	3.0	952	2.7	580	1.5	204	0.5	< .0001
Familial CAD	805	2.6	867	2.5	681	1.7	615	1.6	< .0001

ACS, acute coronary syndrome; CABG, coronary artery bypass graft; CAD, coronary artery disease; COPD, chronic obstructive pulmonary disease; CVD, cerebrovascular disease; CVS, cardiac valve surgery; MI, myocardial infarction; NSTEMI, non-ST elevation myocardial infarction; PCI, percutaneous coronary intervention; PVD, peripheral vascular disease; STEMI, ST elevation myocardial infarction; UAP, unstable angina pectoris; * assessed and recorded at admission.

The proportion of primary PCI dropped significantly in ACS patients in all categories. In STEMI patients, the fraction of primary PCI in all PCI performed did not change dramatically (44.0% to 47.9%,

Table 2). There is remarkable increase in the proportion of anterior myocardial infarction and significant decrease in the proportion of cardiac function defined as Killip III/IV (Table S3). There was more time delay on first medical contact to balloon dilation in 2014 than in 2013 (median 50 *vs* 40, *P*< .01) (Table S4). PCI procedures done through the radial artery had increased markedly from 72% in 2011 to 90.4% in 2014. The use of clopidogrel and GP IIb/IIIa inhibitor dropped significantly. Proportions of novel drugs like ticagrelor and bivalirudin, and of assisted devices such as intra-aortic balloon pump (IABP), intravascular ultrasound (IVUS), optical coherence tomography (OCT), and fractional flow reserve (FFR) measurement, were low in all time periods (Table 2, Table S5, Table S7). In addition, from 2013-2014, thrombolysis in STEMI patients was not altered in terms of performance rate, thrombolytics, and time delay from angina to thrombolysis increased remarkably and the success rate dropped significantly as well (Table S6).

Table 2. Perioperative characteristics of ACS patients undergoing PCI during 2011-2014

	2011		2012		2013		2014		*P* value
	n	%	n	%	n	%	n	%	for trend
pPCI	30800		34974		39524		39361		
Yes	3689	12.0	4359	12.5	4263	10.8	4211	10.7	< .0001
On STEMI	2866	9.3	3499	10.0	3505	8.9	3544	9.0	< .01
pPCI/PCI	2866/6514	44.0	3499/7302	47.9	3505/7889	44.4	3544/7856	45.1	.78
On NSTEMI	334	1.1	372	1.1	349	0.9	365	0.9	< .01
On UAP	489	1.6	488	1.4	409	1.0	302	0.8	< .0001
No	27111	88.0	30615	87.5	35261	89.2	35150	89.3	
Access artery	30800		34800		39524		39361		
Radial	22171	72.0	28266	81.2	34520	87.3	35582	90.4	< .0001
Femoral	8453	27.4	6527	18.7	4803	12.2	3545	9.0	< .0001
Brachial	165	0.5	170	0.5	187	0.5	209	0.5	.94
Others	11	0.0	11	0.0	14	0.0	25	0.1	.06
Contrast type	30080		34154		38585		39361		
Nonionic	30027	99.8	34119	99.9	38493	99.8	39198	99.6	< .0001
Iso-osmolar	10055	33.4	12988	38.0	16540	42.9	20034	50.9	< .0001
Low-osmolar	19972	66.4	21131	61.9	21953	56.9	19164	48.7	< .0001
Ionic	53	0.2	35	0.1	92	0.2	163	0.4	< .0001
Antiplatelet	30800		34974		39524		39361		
Aspirin	29459	95.6	34189	97.8	38267	96.8	38547	97.9	< .0001

Clopidogrel	29486	95.7	34231	97.9	37165	94.0	36122	91.8	< .0001
Ticagrelor	30	0.1	13	0.0	222	0.6	1299	3.3	< .0001
Ticlopidine	54	0.2	50	0.1	520	1.3	1202	3.1	< .0001
Cilostazol	22	0.1	17	0.0	23	0.1	15	0.0	.11
GP IIb/IIIa inhibitor	4670	15.2	6232	17.8	6135	15.5	5099	13.0	< .0001
Anticoagulation	30800		34974		39524		39361		
UFH	18788	61.0	21343	61.0	22885	57.9	24547	62.4	.19
LMWH	9248	30.0	10398	29.7	12622	31.9	12012	30.5	< .01
Fondaparinux	373	1.2	939	2.7	886	2.2	0	0.0	< .0001
Bivalirudin	0	0.0	0	0.0	93	0.2	395	1.0	< .0001
IABP	30800		34974		39524		39361		
Yes	450	1.5	579	1.7	584	1.5	432	1.1	< .0001
No	30350	98.5	34395	98.3	38940	98.5	38929	98.9	
IVUS	30800		34974		39524		39361		
Yes	439	1.4	399	1.1	383	1.0	439	1.1	< .0001
No	30361	98.6	34575	98.9	39141	99.0	38922	98.9	

ACS, acute coronary syndrome; GP IIb/IIIa, glycoprotein IIb/IIIa; IABP, intra-aortic balloon pump; IVUS, intravascular ultrasound; LMWH, low molecular weight heparin; NSTEMI, non-ST elevation myocardial infarction; PCI, percutaneous coronary intervention; pPCI, primary percutaneous coronary intervention; STEMI, ST elevation myocardial infarction; UAP, unstable angina pectoris; UFH, unfractionated heparin.

Under catheterization, artery stenosis > 75% increased significantly in proportions during the study years. Long lesion constitutes approximately one third of the overall lesions, there were increased trends in the proportion of general lesion, total occluded lesion, and thrombus lesion, and decreased trends in long lesion, calcified lesion and bifurcation lesion. The proportion of triple-vessel lesion significantly decreased, while that of solitary vessel lesion increased dramatically. Under PCI, target vessels were primarily solitary with increased trends in proportions of all arteries, followed by double vessels with decreased proportions. Target vessels involving LM consist 3.4% to 4.2% of all PCI procedures. PCI procedures targeting triple vessels had also decreased both in amount and in proportion(Table 3). From 2013 to 2014, the mean implanted stent per patient decreased from 1.5 to 1.4 (P< .01) (Table S7), the majorities implanted stents were made by domestic companies with a decreased proportion over time (Table S8).

Table 3. PCI characteristics of ACS patient during 2011-2014

	2011	2012	2013	2014	*P* value

	n	%	n	%	n	%	n	%	for trend
Artery stenosis	39090		42260		46915		46938		
75-99%	27879	71.3	31048	73.5	34976	74.6	35971	76.6	< .0001
100%	7228	18.5	8642	20.4	9704	20.7	9385	20.0	< .0001
50-75%	3557	9.1	2326	5.5	2003	4.3	1540	3.3	< .0001
< 50%	426	1.1	244	0.6	232	0.5	42	0.1	< .0001
Lesion category	38606		41713		46292		46073		
Long lesion[#]	13571	35.2	14939	35.8	16375	35.4	15736	34.2	< .001
General lesion	12686	32.9	13036	31.3	14874	32.1	15878	34.5	< .0001
Total occluded lesion	4597	11.9	5532	13.3	6058	13.1	5930	12.9	< .001
Calcified lesion	3184	8.2	3006	7.2	3473	7.5	2781	6.0	< .0001
Bifurcation lesion	2545	6.6	2463	5.9	2479	5.4	2891	6.3	< .01
Thrombus lesion	1782	4.6	2469	5.9	2711	5.9	2549	5.5	< .0001
Small vessel[##]	217	0.6	246	0.6	277	0.6	272	0.6	.59
Bypass graft lesion	24	0.1	22	0.1	45	0.1	36	0.1	.12
Lesion vessel[*]	30457		34800		39427		39295		
Triple	12298	40.4	12803	36.8	13253	33.6	12301	31.3	< .0001
Solitary	8580	28.2	11567	33.2	14395	36.5	14912	37.9	< .0001
LAD	5397	17.7	7090	20.4	8544	21.7	8599	21.9	< .0001
RCA	2147	7.0	3111	8.9	3866	9.8	4222	10.7	< .0001
LCX	1036	3.4	1366	3.9	1985	5.0	2038	5.2	< .0001
Double	7308	24.0	8104	23.3	9180	23.3	9374	23.9	.84
LAD + RCA	3694	12.1	3936	11.3	4270	10.8	4285	10.9	< .0001
LAD + LCX	2558	8.4	2968	8.5	3475	8.8	3554	9.0	< .001
LCX + RCA	1056	3.5	1200	3.4	1435	3.6	1535	3.9	< .001
Triple + LM	1540	5.1	1481	4.3	1638	4.2	1644	4.2	< .0001
Double + LM	489	1.6	502	1.4	574	1.5	593	1.5	.41
LAD + LCX + LM	230	0.8	247	0.7	339	0.9	315	0.8	.16
LAD + RCA + LM	195	0.6	212	0.6	198	0.5	215	0.5	< .05
LCX + RCA + LM	64	0.2	43	0.1	37	0.1	63	0.2	.09
Solitary + LM	178	0.6	253	0.7	300	0.8	367	0.9	< .0001
LAD + LM	139	0.5	197	0.6	220	0.6	281	0.7	< .0001
RCA + LM	26	0.1	37	0.1	51	0.1	49	0.1	.09
LCX + LM	13	0.0	19	0.1	29	0.1	37	0.1	< .01
LM	64	0.2	90	0.3	107	0.3	128	0.3	< .01
Target vessel[*]	28278		32836		38176		39224		
Solitary	20801	73.6	25513	77.7	30592	80.1	31456	80.2	< .0001
LAD	10735	38.0	13277	40.4	15749	41.3	15960	40.7	< .0001
LCX	3017	10.7	3563	10.9	4665	12.2	4867	12.4	< .0001
RCA	7049	24.9	8673	26.4	10178	26.7	10629	27.1	< .0001
Double	5713	20.2	5685	17.3	5906	15.5	5886	15.0	< .0001
LAD + LCX	2723	9.6	2683	8.2	2865	7.5	2815	7.2	< .0001
LAD + RCA	1978	7.0	1937	5.9	1904	5.0	1932	4.9	< .0001
LCX + RCA	1012	3.6	1065	3.2	1137	3.0	1139	2.9	< .0001

Solitary + LM	566	2.0	603	1.8	690	1.8	923	2.4	< .001
LAD + LM	482	1.7	531	1.6	600	1.6	782	2.0	< .01
LCX + LM	68	0.2	58	0.2	71	0.2	123	0.3	< .05
RCA + LM	16	0.1	14	0.0	19	0.0	18	0.0	.68
Double + LM	483	1.7	455	1.4	462	1.2	464	1.2	< .0001
LAD + LCX + LM	405	1.4	375	1.1	387	1.0	382	1.0	< .0001
LAD + RCA + LM	73	0.3	69	0.2	69	0.2	72	0.2	< .05
LCX + RCA + LM	5	0.0	11	0.0	6	0.0	10	0.0	.92
Triple	568	2.0	433	1.3	354	0.9	298	0.8	< .0001
LM	97	0.3	113	0.3	153	0.4	173	0.4	< .05
Triple + LM	50	0.2	34	0.1	19	0.0	24	0.1	< .0001

ACS, acute coronary syndrome; LAD, left anterior descending artery; LCX, left circumflex artery; LM, left main artery; PCI, percutaneous coronary intervention; RCA, right coronary artery; # denotes length of lesion > 20mm; ## denotes vessel diameter < 2.5mm; * include anomalous artery, intermediate artery, and vessel graft.

In general, more complications were recorded during PCI than post-PCI, and the overall complications were significantly decreased both in amount and in proportion, either during PCI or post-PCI. During PCI procedures, slow flow, serious dissection, acute thrombosis, perforation, and cardiac tamponade had markedly decreased. As for complications after PCI, acute/subacute stent thrombosis, organ failure, major bleeding/hematoma, contrast reaction, and thromboembolism had decreased trends in proportion during the study years. There were also significantly decreased trends of death both in amount and in proportion, during/after PCI, with the majority of death found after PCI procedures due to cardiogenic triggers (Table 4).

Table 4. In-hospital adverse events of ACS patient undergoing PCI during 2011-2014

	2011 (n = 30800)		2012 (n =34974)		2013 (n = 39524)		2014 (n = 39361)		*P* value for trend
	n	‰	n	‰	n	‰	n	‰	
Complication	496	16.1	539	15.4	429	10.9	256	6.5	< .0001
During procedure*	342	11.1	334	9.5	269	6.8	151	3.8	< .0001
Slow flow	201	6.5	168	4.8	159	4.0	87	2.2	< .0001
Serious dissection	71	2.3	75	2.1	64	1.6	32	0.8	< .0001
Acute thrombosis	54	1.8	48	1.4	36	0.9	23	0.6	< .0001
Perforation	22	0.7	32	0.9	17	0.4	17	0.4	< .05
Cardiac tamponade	11	0.4	17	0.5	9	0.2	7	0.2	< .05
Acute occlusion	11	0.4	24	0.7	19	0.5	12	0.3	.38
Post-procedure	154	5.0	205	5.9	160	4.0	105	2.7	< .0001
Acute/subacute ST	46	1.5	49	1.4	37	0.9	30	0.8	< .001

Organ failure	37	1.2	31	0.9	29	0.7	19	0.5	< .001
Organ support	8	0.3	2	0.0	7	0.2	3	0.0	.15
Major bleeding/hematoma	19	0.6	19	0.5	23	0.6	6	0.2	< .01
Organ bleeding	14	0.5	21	0.6	11	0.3	11	0.3	.06
Postoperative MI	10	0.3	20	0.6	14	0.4	7	0.2	.10
Contrast reaction	7	0.2	10	0.3	3	0.0	2	0.0	< .01
Postoperative infection	5	0.2	6	0.2	8	0.2	3	0.0	.40
Thromboembolism	4	0.1	11	0.3	2	0.0	2	0.0	< .05
Emergent surgery	4	0.1	2	0.0	1	0.0	2	0.0	.18
Others	28	0.9	56	1.6	43	1.1	26	0.7	.06
Death	166	5.4	179	5.1	150	3.8	113	2.9	< .0001
During PCI	41	1.3	30	0.9	22	0.6	16	0.4	< .0001
Cardiogenic									
Yes	34	1.1	25	0.7	16	0.4	16	0.4	< .0001
No	1	0.0	1	0.0	2	0.0	0	0.0	.52
Uncertain	6	0.2	4	0.1	4	0.1	0	0.0	< .05
PCI related									
Yes	4	0.1	1	0.0	1	0.0	4	0.1	.76
No	23	0.7	15	0.4	11	0.3	11	0.3	< .01
Uncertain	14	0.5	14	0.4	10	0.3	1	0.0	< .001
Post-PCI	125	4.1	149	4.3	128	3.2	97	2.5	< .0001
Cardiogenic									
Yes	102	3.3	108	3.1	108	2.7	82	2.1	< .01
No	10	0.3	22	0.6	8	0.2	9	0.2	.08
Uncertain	13	0.4	19	0.5	12	0.3	6	0.2	< .05
PCI related									
Yes	4	0.1	5	0.1	7	0.2	8	0.2	.40
No	88	2.9	120	3.4	100	2.5	80	2.0	< .01
Uncertain	33	1.1	24	0.7	21	0.6	9	0.2	< .0001

ACS, acute coronary syndrome; MI, myocardial infarction; PCI, percutaneous coronary intervention; ST, stent thrombosis.

Discussion

To the best of our knowledge, this is the first large, nationwide study of ACS patients undergoing PCI in Chinese military hospitals. Compared with contemporary developed country such as the U.S., the proportion of hospitals capable of performing PCIs more than 400 cases was substantially low (17.1% *vs* 41.5% in U.S.).[10] Accordingly, the application rates of assisted devices were also low, such as IABP (1.1% to 1.7%), temporary pacemaker (1.9% to 2.4%), IVUS (1.0% to 1.4%), OCT (0.1%), and FFR measurement (0.1% to 0.5%), as these support is available with experienced interventional

cardiologists and skilled support staff in high-volume well-equipped facilities. Out data also suggest great regional disparities of PCI procedures performed on ACS patients, with patients in the north region of China (North China, Northwest, and Northeast) consumed the majority of interventional resources (65.5% of all PCI cases). This also reflects pandemic state of unstable coronary artery disease in these regions.[11-13] In this regard, medical resources shall be prioritized to better serve disparate needs in different regions, especially the north region of China. Furthermore, the health care coverage system in contemporary China is also concerning, as during 2013-2014 only 53.4% to 53.6% ACS patients were covered under urban resident medical service with high reimbursement rate, while 20.1% to 22.1% patients were covered under new rural cooperative medical service with low reimbursement rate, and 16.3% to 17.2% patients were uncovered.[14-16] Given the great economic burdens ACS patients bear on PCI procedures and medications during hospitalization and thereafter,[17-19] the current medical coverage patterns shall be optimized to improve the quality of life for these patients as well as their families. Nevertheless, the overall decreased trends in proportions of comorbidities suggest the effectiveness of cardiovascular related disease control during 2011-2014 in China.

Primary PCI was performed with high prevalence in hospitals of developed countries. For example, in a recent nationwide Belgian STEMI registry during 2009-2013, 89.6% of STEMI patients underwent primary PCI.[20] In the U.S. NCDR 2010-2011 report, the primary PCI consisted 84.8% of all PCI performed for STEMI patients.[21] However, the proportion of primary PCI performed on STEMI patients was still very low in this study, and this proportion did not change significantly over time (44.0% in 2011 to 45.1% in 2014). This could be explained by the low proportion of high-volume PCI-capable hospitals in China, as these hospitals are well-equipped with experienced interventional cardiologists and skilled support staff, which are all required for the successful implementation of primary PCI.

Nevertheless, median time delay of first medical contract (FMC) to balloon dilation for primary PCIs done with STEMI patients during 2013-2014 were 50 minutes, which were far below the guideline-recommended threshold of 90 minutes.[22] This important quality improvement might be catalyzed by the awareness of the performance metric for participating hospitals, as study demonstrated that patients treated in hospitals that had been enrolled in the D2B Alliance for > 3 months were significantly more likely to have D2B times of < 90 minutes than patients treated in non-enrolled hospitals.[23] In this regard, the scenario of D2B time in real world practice might be less satisfying, as performance metrics were largely unmonitored. Furthermore, given that time delay of angina onset to FMC was still huge (median 270 minutes), great efforts are still needed to promote broader initiatives at a systems level to reduce total ischemic time, which was shown as the principal determinant of outcome.[24,25] These efforts might include patient education, improvements in emergent medical service and emergent department care, establishment of networks of non-PCI-capable and PCI-capable hospitals, and work with policy makers to implement healthcare system reform.[26-32]

In a recent large retrospective study, Xin Zheng and colleagues reported dramatic increase of the adoption of radial artery access from 3.5% to 79.0% in the practice of interventional cardiology in China during 2001-2011.[6] In this study of ACS patients, the trend is still rising, with 72.0% PCI procedures accessed via radial artery in 2011 to 90.4% in 2014, compared with 10.9% cases/procedures performed by means of a radial approach in 2011 to 25.2% in 2014 in the United States [NCDR]. In a recent meta-analysis of large, high-quality, contemporary randomized studies comparing radial and femoral access in invasively managed patients with ACS, radial access was found to reduce mortality, major adverse cardiovascular events, and major bleeding.[33] Similarly, with the rising adoption of radial access from 2011 to 2014 in this study, the proportion of major bleeding or hematoma after PCI and

in-hospital mortality were both significantly decreased over time. In this regard, transradial access shall be advocated in countries that use it less frequently.

Compared with data reported from the NCDR (National Cardiovascular Data Registry) in the U.S. during 2010-2011,[21] uses of ticagrelor and bivalirudin were extremely low for ACS patients undergoing PCI during 2011-2014 (less than 3.3% and 1.0%, respectively), although their proportions were rising. This might be explained by the delayed introduction of these drugs into Chinese pharmaceutical market, as well as uncovered status under the drug list of Medical Service in China. Given the great superiorities of these novel antiplatelet and anticoagulation drugs,[1,34] coordinated advocacy efforts are needed to work with policy makers to include these drugs into the list for coverage, to improve the quality of care for ACS patients and the outcomes of PCI procedures. The China PEACE-Retrospective CathPCI Study group recently reported that the proportions of patients who received a glycoprotein IIb/IIIa inhibitor and clopidogrel both increased from 2001 to 2011 in non-military hospitals in China.[6] Unlike their findings, in this nationwide study of ACS patients undergoing PCI in military hospitals from 2011 to 2014, the proportions of clopidogrel and glycoprotein IIb/IIIa inhibitor both decreased significantly (95.7% to 91.8% and 15.2% to 13.0%, respectively), it might suggest different patterns of medications between non-military hospitals and military hospitals in the field of interventional cardiology, or just be a result of rapidly evolved medical practice in all hospitals in contemporary China, possibly due to the emergence of novel P2Y12 inhibitor ticagrelor and novel anticoagulant bivalirudin in China.

Nevertheless, our data demonstrated great improvement in the quality metrics of PCI procedures during the study years. The proportion of non-obstructive CAD (stenosis < 50%) was 1.1% in 2011. Although the proportion is much higher than that reported in NCDR during 2010 to 2011 (0.2%), it has

dropped substantially to 0.1% in 2014. Out study also revealed dramatic changes in the pattern of the extent of CAD, with the dominance of 3-vessel disease in 2011 (40.4%) shifted to the dominance of 1-vessel disease in 2014 (37.9%) and no obvious change in 2-vessel disease (23.3% to 24.0%). This trend was quite different with distributions found in patients undergoing PCI in the U.S. during 2010-2011 (38.1%, 32.6%, and 39.1% for 1-, 2-, and 3-vessel disease, respectively).[21] In treated lesion vessels, although there were remarkable increase of 1-vessel disease and significant decreases of 2-and 3-vessel diseases in proportions, interventional operators in Chinese military hospitals still treated lower proportion of 1-vessel disease and higher proportion of 2-vessel disease in 2014 than peers in the U.S. during 2010-2011 (80.2% *vs* 86.2% and 15.0% *vs* 12.8%, respectively).[21] Meanwhile, operators implanted less stents per patient in 2014 than in 2013 (mean 1.4 *vs* 1.5), which was also remarkably less than those implanted during 2001-2011 in China PEACE study (mean 1.4 in 2001, 1.7 in 2006, and 1.8 in 2011).[6] Of note, the proportion of treated vessels involving left main artery (3.4% to 4.2%) was significantly higher than proportions reported in the U.S. during 2010-2011(1.8%)[21] as well as in Chinese non-military hospitals during 2001-2011 (0.4%-2.1%).[6] The facts that considerable amount of grade 0-2 TIMI flow before PCI almost disappeared after PCI suggest high quality of performance of PCI procedures. Especially, compared with data in 2013, higher proportions of grade 0 and 1 TIMI flow before PCI turned to higher proportion of grade 3 TIMI flow after PCI in 2014, suggesting the quality of performance was still improving. The relatively low and decreasing rate of overall complications (1.6% in 2011 to 0.7% in 2014) and death (0.5% in 2011 to 0.3% in 2014) for PCI procedures might be attributable to the decrease of worse cardiac function over time (patients with Killip III-IV grades decreased significantly from 2011-2013, Table S3). On the other hand, the consistent low rates are also suggestive of good performance of cardiac intervention on these patients.

Finally, although domestic-made stents consist the majority of stents used during PCI procedures, their proportion dropped significantly (65.1% in 2013 to 61.8% in 2014), which was quite different from the scenario of dramatic increase of domestic stents used in non-military hospitals in China during 2001-2011 (1.6% in 2001 to 74.8% in 2011).[6]

Some limitations of this study should be noted. First, the partial revision of the registry form in 2013 has made comparisons of some critical measures impossible during 2011-2014 consecutively. However, the purpose of the necessary revision was to reflect contemporary changes in the practice of cardiac intervention during the study years. And we analyzed all critical measures provided they were available. Second, due to the gigantic number of nationwide enrolled patients and limit of sufficient funding and other resources, we only compared the in-hospital outcomes for the patients. However, it's possible to follow up the long-term outcomes for these patients, given that contact information of most patients were collected. Third, in this study comparisons of data with other studies were not matched exactly both temporally and categorically, as to the best of our knowledge, the same large scale, nationwide registries of acute coronary syndromes during the same study period were not available. Nevertheless, we believe this study has given an updated and comprehensive overview of contemporary practice of interventional cardiology in military hospitals in China.

CONCLUSION

This study outlined the general profiles of cardiac intervention practice in contemporary military hospital in China. Our data revealed the overall interventional resources were still limited, with great disparities of interventional resources and consumptions in different geographical regions of China, and major gaps still exist in medical coverage for ACS patients. Nonetheless, our study also demonstrated notable improvements in the quality of care and major differences in the characteristics of PCI practice

compared with contemporary developed countries as well as non-military hospitals in China. Our findings can serve as an indispensable addition to a comprehensive overview of the practice of cardiac intervention in China.

Contributors RZ participated in the data collection an drafted the manuscript. KX participated in the data collection and design of the study. YL and YH participated in the design of the study and undertook statistical analyses. All authors were involved in writing the paper and had final approval of the submitted and published versions.

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Competing interests None declared.

Ethics approval This study was approved by the ethics committee of the General Hospital of Shenyang Military Region. The requirement of informed consent was waived due to the nature of the retrospective study. All participating hospitals accepted the ethics committee approval.

Data sharing statement No additional data are available.

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Figure Legends

Figure 1. Overall and regional distributions of PCI-capable military hospitals and PCI procedures performed.

Military hospitals were divided by their annual PCI volume with a threshold of 400 cases per year (A), as well as further by geographical regions (C); The overall PCI procedures performed during 2011-2014 were also grouped by annual PCI volumes of hospitals (B), and by regions (D). Northern China include North China, Northwest China and Northeast China, Southern China include South China, East China, Central China, and Southwest China.

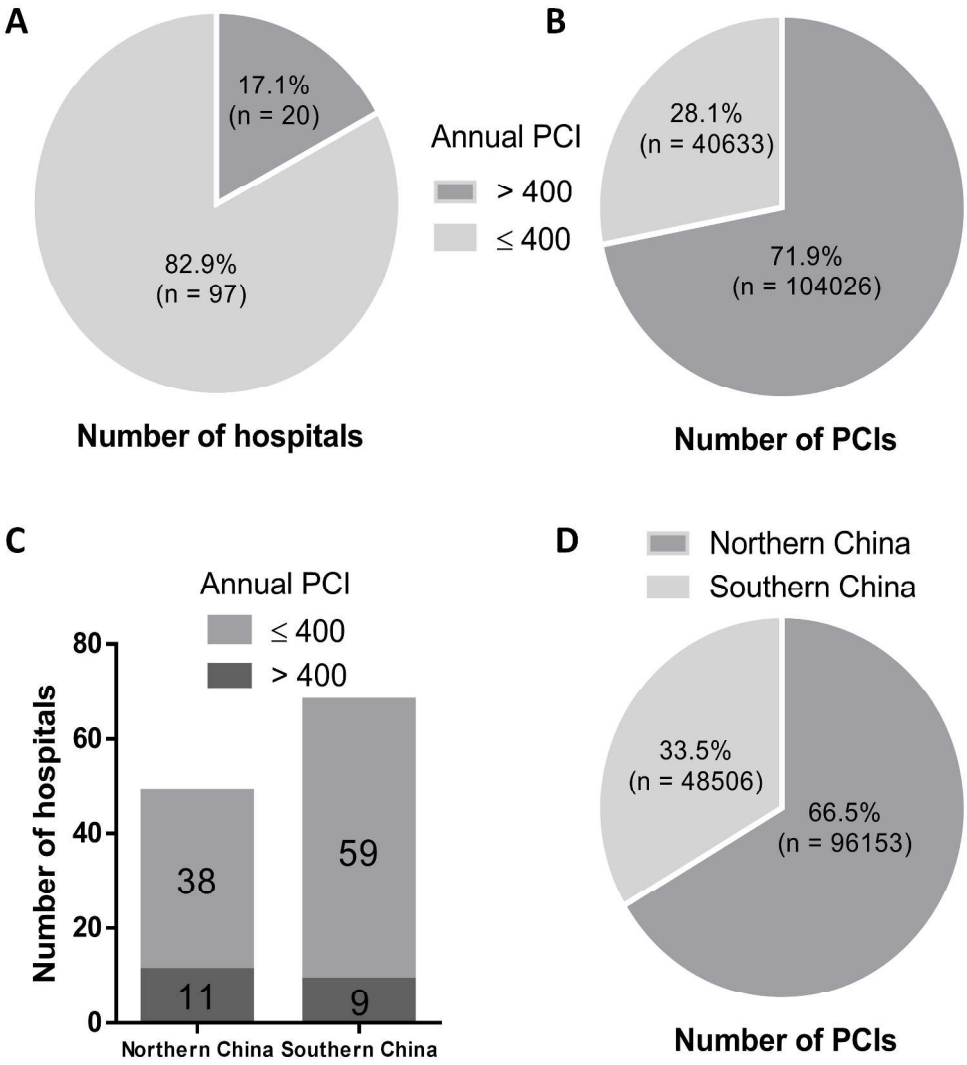

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Table S1. Distribution of ACS patients undergoing PCI in participated hospitals during 2011-2014

Hospital	Region	2011	2012	2013	2014
General Hospital of Shenyang Military Region	Northeast	3118	4198	5597	6103
The 463 Hospital	Northeast	224	332	250	374
The 210 Hospital	Northeast	190	197	211	207
The 313 Hospital	Northeast	130	237	305	277
The 202 Hospital	Northeast	115	139	111	154
The 208 Hospital	Northeast	80	113	77	48
The 211 Hospital	Northeast	59	73	71	50
The 201 Hospital	Northeast	7	33	20	10
The 205 Hospital	Northeast	1	25	47	61
General Hospital of Jilin PAP Corps	Northeast	0	0	2	0
General Hospital of PLA	North China	2094	1993	1782	2562
The Affiliated Hospital of PAP College of Logistics	North China	1602	1324	1355	1391
Bethune International Peace Hospital	North China	927	855	1009	950
General Hospital of PAP	North China	859	753	757	974
The 252 Hospital	North China	675	749	848	933
General Hospital of Navy	North China	482	667	623	791
The 304 Hospital	North China	398	502	263	254
The 254 Hospital	North China	391	166	158	258
The 309 Hospital	North China	312	376	435	295
The General Hospital of Beijing Military Region	North China	240	372	408	488
The Second Artillery General Hospital	North China	236	188	215	181
General Hospital of Air Force	North China	218	221	293	407
The 305 Hospital	North China	213	257	429	492
The 306 Hospital	North China	192	367	386	368
The 307 Hospital	North China	125	137	126	102
The 264 Hospital	North China	75	101	142	177
The 261 Hospital	North China	68	59	43	48
The 251 Hospital	North China	49	5	97	0
The 263 Hospital	North China	0	0	21	48
The 285 Hospital	North China	0	59	100	67
The 464 Hospital	North China	0	86	139	70
The Second Hospital of Beijing PAP Corps	North China	0	34	13	30
General Hospital of Beijing PAP Corps	North China	0	35	37	33
General Hospital of Hebei PAP Corps	North China	0	89	56	5
General Hospital of Shanxi PAP Corps	North China	0	236	179	162
Changhai Hospital of SMMU	East China	750	1206	1320	1828
General Hospital of Nanjing Military Region	East China	581	621	470	486
General Hospital of Jinan Military Region	East China	472	393	267	335
Changzheng Hospital of SMMU	East China	337	362	499	375
The 88 Hospital	East China	209	193	168	135
The 148 Hospital	East China	186	203	166	165

The 105 Hospital	East China	164	70	64	152
The 401 Hospital	East China	162	144	92	33
The 97 Hospital	East China	162	197	260	194
Fuzhou General Hospital of PLA	East China	158	196	344	272
Anqing Hospital of Navy	East China	91	62	59	74
The 101 Hospital	East China	71	96	107	114
The 89 Hospital	East China	67	46	68	62
The 107 Hospital	East China	65	113	181	40
The 171 Hospital	East China	59	70	105	72
The 404 Hospital	East China	50	98	73	78
The 94 Hospital	East China	41	68	84	116
The 411 Hospital	East China	37	38	53	64
The 174 Hospital	East China	24	120	91	88
The 180 Hospital	East China	19	65	122	136
The 85 Hospital	East China	11	45	52	24
The 98 Hospital	East China	10	9	10	42
The 117 Hospital	East China	9	18	16	20
General Hospital of Zhejiang PAP Corps	East China	7	71	70	47
The 123 Hospital	East China	0	42	70	54
The 175 Hospital	East China	0	18	117	91
The 456 Hospital	East China	0	6	6	10
The 92 Hospital	East China	0	49	102	112
General Hospital of Fujian PAP Corps	East China	0	11	17	22
General Hospital of Guangzhou Military Region	South China	685	830	830	713
The 181 Hospital	South China	54	55	56	44
The 303 Hospital	South China	49	7	48	62
The 458 Hospital	South China	32	32	97	78
The 163 Hospital	South China	17	57	42	13
The 169 Hospital	South China	0	7	5	3
General Hospital of Guangdong PAP Corps	South China	0	112	211	195
General Hospital of Hunan PAP Corps	South China	0	49	44	22
The 425 Hospital	South China	0	0	18	0
The 187 Hospital	South China	0	0	0	40
The 422 Hospital	South China	0	0	0	104
The 425 Hospital	South China	0	0	0	16
Hainan Hospital of General Hospital of PLA	South China	0	0	0	146
Wuhan General Hospital of PLA	Central China	482	394	482	462
The 150 Hospital	Central China	460	244	124	484
The 91 Hospital	Central China	371	479	465	270
The 153 Hospital	Central China	183	180	76	93
The 371 Hospital	Central China	153	170	216	48
General Hospital of Henan PAP Corps	Central China	145	91	142	52
The 152 Hospital	Central China	70	62	39	89
The 155 Hospital	Central China	47	132	132	147

The 161 Hospital	Central China	47	77	66	76
The 159 Hospital	Central China	19	38	67	23
General Hospital of Hubei PAP Corps	Central China	0	61	101	75
The 477 Hospital	Central China	0	0	0	125
Xijing Hospital of FMMU	Northwest	4438	4514	5456	5326
Tangdu Hospital of FMMU	Northwest	998	1287	1749	325
General Hospital of Lanzhou Military Region	Northwest	762	685	784	749
Urumchi General Hospital of PLA	Northwest	469	489	623	617
General Hospital of Shannxi PAP Corps	Northwest	452	362	415	166
The 451 Hospital	Northwest	182	157	181	125
The 3 Hospital	Northwest	105	86	84	47
The 474 Hospital	Northwest	94	113	157	175
The 323 Hospital	Northwest	74	105	109	97
The 273 Hospital	Northwest	58	57	95	113
The 18 Hospital	Northwest	0	4	9	20
General Hospital of Ningxia PAP Corps	Northwest	0	48	38	9
General Hospital of Xinjiang PAP Corps	Northwest	0	32	28	33
The 1 Hospital	Northwest	0	0	0	19
Kunming General Hospital of PLA	Southwest	926	878	1102	993
Xinqiao Hospital of TMMU	Southwest	816	1130	1125	1393
Southwest Hospital of TMMU	Southwest	790	903	863	364
Daping Hospital of TMMU	Southwest	602	742	846	820
The General Hospital of Chengdu Military Region	Southwest	237	543	748	733
The 452 Hospital	Southwest	79	53	42	81
The 59 Hospital	Southwest	42	47	44	34
Tibet General Hospital of PLA	Southwest	23	0	0	0
The 324 Hospital	Southwest	0	0	21	29
The 37 Hospital	Southwest	0	15	4	19
The 44 Hospital	Southwest	0	4	21	15
Chengdu Hospital of Sichuan PAP Corps	Southwest	0	0	4	0
General Hospital of Sichuan PAP Corps	Southwest	0	27	57	68
Leshan Hospital of Sichuan PAP Corps	Southwest	0	4	0	0

ACS, acute coronary syndrome; PAP, people's armed police; PCI, percutaneous coronary intervention; PLA, people's liberty army; FMMU, fourth military medical university; SMMU, second military medical university; TMMU, third military medical university.

Table S2. Medical coverage of ACS patients undergoing PCI during 2013-2014

	2013*		2014		
	n	%	n	%	*P*
Medical coverage	18217		39361		
Urban resident MS	9728	53.4	21083	53.6	.72
New rural cooperative MS	3665	20.1	8714	22.1	< .0001
Self-paid	3136	17.2	6401	16.3	< .01
Free MS	572	3.1	915	2.3	< .0001

Commercial insurance	518	2.8	911	2.3	.0001
Others	793	4.4	2043	5.2	< .0001

ACS, acute coronary syndrome; MS, medical service; PCI, percutaneous coronary intervention; * Data were from part of 2013, not from the calendar year due to a systematic revision of the registry form since 2013.

Table S3. Distribution of location of prior MI and Killip classification of ACS patients undergoing PCI during 2011-2013

	2011		2012		2013*		*P* value
	n	%	n	%	n	%	for trend
Prior MI							
Location	5306		5355		3255		
Inferior	2449	46.2	2520	47.1	1458	44.8	.33
Anterior	2189	41.3	2261	42.2	1450	44.5	< .01
Anteroseptal	424	8.0	361	6.7	176	5.4	< .0001
Posterior	114	2.1	99	1.8	85	2.6	.26
Anterolateral	103	1.9	85	1.6	47	1.4	.07
Right ventricular	27	0.5	29	0.5	39	1.2	< .001
Killip classification	5497		5897		4035		
I	2034	37.0	2382	40.4	1499	37.1	.59
II	2405	43.8	2454	41.6	1986	49.2	< .0001
III	768	14.0	792	13.4	437	10.8	< .0001
IV	290	5.3	269	4.6	113	2.8	< .0001

ACS, acute coronary syndrome; MI, myocardial infaction; PCI, percutaneous coronary intervention; * Data were from part of 2013, not from the calendar year due to a systematic revision of the registry form since 2013.

Table S4. Time delay of STEMI patients undergoing primary PCI during 2013-2014

	2013*	2014	
	Median (IQR)	Median (IQR)	*P*
	(n = 1495)	(n = 3484)	
Time delay, mins			
Angina to Balloon	270 (190-415)	270 (190-421)	.65
Angina to FMC	225 (130-350)	220 (121-360)	.53
FMC to Balloon	40 (30-70)	50 (30-75)	< .01

FMC, first medical contact; IQR, interquartile range; MS, medical service; PCI, percutaneous coronary intervention; STEMI, ST elevation myocardial infarction; * Data were from part of 2013, not from the calendar year due to a systematic revision of the registry form since 2013.

Table S5. Assisted device applied perioperatively in ACS patients undergoing PCI during 2011-2013

	2011		2012		2013*		*P* value
	n	%	n	%	n	%	for trend
Assisted device	30800		34974		21307		
Temporary pacemaker	730	2.4	797	2.3	395	1.9	< .001
OCT	19	0.1	43	0.1	30	0.1	< .01

ACS, acute coronary syndrome; OCT, optical coherence tomography; PCI, percutaneous coronary intervention;

[*] Data were from part of 2013, not from the calendar year due to a systematic revision of the registry form since 2013.

Table S6. Thrombolysis of STEMI patients during 2013-2014

	2013[*]		2014		
	n	%	n	%	*P*
Thrombolysis	3564		7856		
Yes	52	1.5	118	1.5	.86
No	3512	98.5	7738	98.5	
Thrombolytic	52		118		
Urokinase	33	63.5	67	56.8	.41
Reteplase	8	15.4	17	14.4	.87
Alteplase	4	7.7	17	14.4	.31
Prourokinase	3	5.8	12	10.2	.56
Others	4	7.7	5	4.2	.46
Time delay, mins[#]					
Angina to thrombolysis	150 (89-223)		190 (130-301)		< .05
Angina to FMC	120 (60-210)		160 (80-270)		.08
FMC to thrombolysis	30 (20-33)		30 (20-40)		.64
Thrombolysis success	52		118		
Yes	44	84.6	73	61.9	< .01
No	8	15.4	45	38.1	

FMC, first medical contact; STEMI, ST elevation myocardial infarction; [*] Data were from part of 2013, not from all of the calendar year due to a systematic revision of the registry form since 2013; [#] data in the subitems were shown as median (interquartile).

Table S7. PCI outcomes of ACS patients during 2013-2014

	2013[*]		2014		
	n	%	n	%	*P*
TIMI flow pre-PCI	21710		46928		
0	4254	19.6	10840	23.1	< .0001
1	2139	9.9	6763	14.4	< .0001
2	2850	13.1	4909	10.5	< .0001
3	12467	57.4	24416	52.0	< .0001
TIMI flow post-PCI	21705		46922		
0	347	1.6	645	1.4	< .05
1	82	0.4	183	0.4	.81
2	283	1.3	374	0.8	< .0001
3	20993	96.7	45720	97.4	< .0001
Guiding wire through lesion	21670		46890		
Yes	21322	98.4	46184	98.5	.32
No	348	1.6	706	1.5	
Stent restenosis[#]	21734		46930		
Yes	354	1.6	857	1.8	.07
No	21380	98.4	46073	98.2	
Residual stenosis of lesion	21660		46892		

< 10%	19912	91.9	45367	96.7	< .0001
10-50%	763	3.5	537	1.1	< .0001
> 50%	985	4.5	988	2.1	< .0001
FFR applied	21756		46938		
Yes	107	0.5	189	0.4	.10
No	21649	99.5	46749	99.6	
Luminal stenosis by IVUS	178		439		
Percentage, %	76 (70-85)		77 (71-83)		.52
Minimal luminal area, mm^2	3.04 (2.68-4.00)		3.25 (2.60-4.00)		.59
Implanted stent per patient**	1.5 ± 0.7		1.4 ± 0.7		< .01

ACS, acute coronary syndrome; IVUS, intravascular ultrasound; FFR, fractional flow reserve; PCI, percutaneous coronary intervention; TIMI, thrombolysis in myocardial infarction; * Data were from part of 2013, not from the calendar year due to a systematic revision of the registry form since 2013; # within lesion categories; ** Mean ± SD, n = 19363, 42299 in 2013-2014, respectively.

Table S8. Stent manufacturer of ACS patients undergoing PCI during 2013-2014

	2013*		2014		
	n	%	n	%	*P*
Stent manufacturer	28181		60847		
Domestic	18345	65.1	37591	61.8	< .0001
MicroPort	6855	24.3	13862	22.8	< .0001
JW Medical	6678	23.7	13214	21.7	< .0001
Lepu Medical	4503	16.0	9868	16.2	.37
Yinyi Biotech	309	1.1	647	1.1	.66
Foreign	6550	23.2	14931	24.5	< .0001
Abbott	3164	11.2	6943	11.4	.42
Medtronic	2464	8.7	5514	9.1	.12
Boston scientific	922	3.3	2474	4.1	< .0001
Others	3286	11.7	8325	13.7	< .0001

ACS, acute coronary syndrome; PCI, percutaneous coronary intervention; * Data were from part of 2013, not from the calendar year due to a systematic revision of the registry form since 2013.

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4,5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	5
		(*b*) Describe any methods used to examine subgroups and interactions	5
		(*c*) Explain how missing data were addressed	5
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6,7,8,9,10,11
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	11,12
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	In Suplementary tables.
		(*b*) Report category boundaries when continuous variables were categorized	11
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	12,13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	17
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	17
Generalisability	21	Discuss the generalisability (external validity) of the study results	17
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	18

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Percutaneous Coronary Intervention in Patients with Acute Coronary Syndrome in Chinese Military Hospitals, 2011-2014, a retrospective observational study of a national registry.

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Secondary Subject Heading:	Health services research
Keywords:	Acute Coronary Syndrome, Percutaneous Coronary Intervention, Trending, Quality of care

Percutaneous Coronary Intervention in Patients with Acute Coronary Syndrome in Chinese Military Hospitals, 2011-2014, a retrospective observational study of a national registry.

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[#]The participating hospitals of the NRCIMH Program are listed in Table S1 in the Supplement.

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Running head: PCI performance in ACS

ABSTRACT

Objectives Interventional treatment of patients with ACS (Acute Coronary Syndrome) is surging dramatically in China in recent years, whereas nationwide assessments of the quality of PCI (Percutaneous Coronary Intervention) procedural performance and outcomes are scarce. We aimed to provide an updated and real-world overview of the performance of PCI in ACS patients since 2011 in China after the China PEACE study from 2001 to 2011.

Methods In this cross-sectional study, data were extracted from the NRCIMH (National Registry of Cardiovascular Intervention in Military Hospitals) database to create a national sample of 144 659 ACS patients undergoing PCI at 117 military hospitals in all regions of China from calendar year 2011 to 2014. Patient characteristics, procedural performance, PCI outcomes and adverse events and temporal changes were analyzed.

Results During 2011 to 2014, ACS patients undergoing PCI increased dramatically. Small numbers of high-volume hospitals performed the majority of PCI procedures. However, only half of these patients were adequately covered and proportions for the use of assisted devices and novel medications were relatively small. Radial artery access was still increasing with time. Primary PCIs were performed on 45.4% STEMI patients with PCI procedures. 3.8% lesion vessels involve left main artery. Implanted stents, the overall complications and in-hospital mortality were decreasing remarkably.

Conclusions In Chinese military hospitals, interventional resources were limited with great regional disparities, there are still gaps to be filled to better serve ACS patients. Our findings can serve as an indispensable supplement to a more comprehensive understanding of the practice of contemporary cardiac intervention in China.

Key Words: Acute Coronary Syndrome; Percutaneous Coronary Intervention; Trending; Quality of

care.

Strengths and limitations of this study

- This is the first nationwide retrospective observational study of the performance of PCI in ACS patients covering all geographic regions of mainland China.
- The assessment was based on real world registry data with sequential enrollment from calendar year 2011 to 2014.
- PCI outcomes were based on in-hospital data and no follow-up were done to evaluate the long term improvement of ACS patients undergoing PCI.
- Although all PCI-capable military hospitals participated in this program, patient outcomes might be differentially affected by interventionist in hospitals with various volumes of PCI procedures each year, thus may confound the overall results.

INTRODUCTION

Due to an aging population and increasing prevalence of cardiovascular risk factors, China is facing an epidemic of acute coronary syndrome (ACS). In China, military hospitals play an indispensible role in providing health care service largely to civilian patients in peacetime[1-5] ,yet their performance of care were underinvestigated. The drastic increase of acute coronary syndrome (ACS) in China has also catalyzed the growth of percutaneous coronary intervention (PCI) in quantity.[6] However, whether the rapid growth of PCI volume has translated into good quality of care for these ACS patients treated in military hospitals remains unclear. The adoption of emerging technologies varies substantially across different areas of China. The lack of a nationwide comprehensive assessment of interventional practice hampered the improvement of health care provided to these patients. Understand these barriers within the healthcare system of China is imperative to implement change.

The China PEACE (Patient-Centered Evaluative Assessment of Cardiac Event) study was a nationally representative, retrospective study of patients undergoing coronary catheterization and PCI at 55 urban Chinese non-military hospitals in calendar years 2001, 2006, and 2011.[6] This study found that there were notable changes in practice, including use of radial PCI and medicated stents, yet persistent gaps still existed to improve care.[6] Military hospitals are independently administered by the Joint Logistic Support Center (the former General Logistics Department) of PLA (People's Liberation Army) in China. To facilitate the management of cardiovascular intervention in military hospitals, the Quality Control Center of Intervention for Cardiovascular Diseases was founded in 2009 by the Bureau of Healthcare of the General Logistics Department.[7] Quality Improvement Initialtives were launched thereafter to standardize the care of acute myocardial infarction nationwide in military hospitals, including the establishment of Chest Pain Center in qualified cardiac centers.[8] To standardize and monitor the quality of care for patients undergoing PCI procedures, we conducted the NRCIMH (National Registry of Cardiovascular Intervention in Military Hospitals) study.[9-11] During calendar years 2011 to 2014, 117 PCI-capable military hospitals in all seven geographical regions of China and 144 659 ACS patients undergoing PCI procedures were included in this study. Patient characteristics, quality of procedural performance, PCI outcomes, and in-hospital adverse events and their temporal changes were analyzed over time.

Methods

Study Design

This study was a cross-sectional study using a registered dataset. The original data for this study was extracted from the National Registry of Cardiovascular Intervention in Military Hospitals (NRCIMH, web access via http://www.xxgjr.com). This database collected social-demographic, medical and

interventional data of patients who had cardiovascular disease and underwent cardiac interventions since October 2010 in all military hospitals nationwide that are qualified to perform cardiac catheterization and PCI.[9-11] Patient demographics, clinical characteristics, and treatment patterns during hospitalization were collected by physicians who were in charge of the patient, and coronary catheterization or PCI related information were collected by the responsible operator or technical assistant. Patient data were censored and uploaded into the database by designated medical personnel in each individual hospital. The majority of patients had coronary artery disease and underwent PCI. This study was approved by the ethics committee of the General Hospital of Shenyang Military Region. The requirement of informed consent was waived due to the nature of the retrospective study. All participating hospitals accepted the ethics committee approval.

Study Population

ACS Patients (with definite discharge diagnosis of either STEMI [ST-segment elevation myocardial infarction], NSTEMI [non-ST-segment elevation myocardial infarction], or unstable angina) undergoing interventional procedures in all 117 military hospitals (Table S1) from January 1, 2011 to December 31, 2014 were included in this study. Diagnoses were made according to the China National Guidelines for ACS,[12,13] which are consistent with guidelines in the US.[14,15] Due to the large-volume information inputed into this Registry, patients with missing data were excluded in specific categorical analyses, including age, gender, region of hospital, access artery, contrast type, lesion vessel, target vessel. For measured categories like artery stenosis and lesion category, their sum exceed the total number of patients enrolled in each study year is because each patient usually had more than one stenosed/lesioned vessel. For the sake of clarity, the sum for each measured variable category was listed in the column of each category unless otherwise specified. Data integrity for each measure

category was not less than 91.8% in this study.

Variables and Definitions

We collected data from a unified registry form abstracted from the original Database systems, including baseline characteristics (diagnosis, patient category, age, gender, ethnicity, region of admission hospital, medical history), perioperative characteristics (primary PCI composition, access artery, contrast type, antiplatelet and anticoagulation medications, assisted devices), PCI outcomes (stenosis pre-PCI, lesion category, lesion vessel, target vessel), and adverse outcomes including complication and death both during PCI and post-PCI. Medical histories including histories of myocardial infarction, cerebrovascular disease, peripheral vascular disease, cardiac valve surgery, CABG, and PCI were collected by physicians in charge of that patient (mainly via patient's own statement and further verified, if any, by documentation in previous admission notes, discharge diagnoses, or corroborating laboratory test results) and were uploaded into the registry database. For the convenience of calculation, anomalous artery, intermediate artery and vessel graft lesion as well as interventions done in these vessels were all merged into the individual categories. In addition, due to a systematic revision of the registry form since 2013, partial data were analyzed and summarized in the supplement, including location and Killip classification of MI history, assisted device used during 2011-2013, information regarding medical coverage, thrombolysis of STEMI patient, PCI outcomes, and stent manufacturer during 2013-2014.

Patients with corrected TIMI frame count (cTFC) values exceeding the thresholds by greater than 2 SD (standard deviations) for the particular vessel were recognized as having coronary slow flow.[16] Major bleeding was defined as any intracranial bleeding, absolute hemoglobin decrease of at least 50 g/L, bleeding resulting in hypovolemic shock, or fatal bleeding (bleeding that resulted directly in death

within 7 days). Acute/subacute stent thrombosis was defined according to the Academic Research Consortium criteria.[17] Postoperative myocardial infarction was diagnosed in accordance with the universal definition of type 4 myocardial infarction.[18] The cause of death was adjudicated as cardiogenic death, PCI-related death, or uncertain.

Statistical Analysis

We used percentages to describe categorical variables and median with interquartile ranges (IQRs) to describe continuous variables unless otherwise specified. χ^2 trend tests were used to examine trends across different study years for categorical variables. For the comparison of data between 2013 and 2014, χ^2 tests were used for categorical variables and Mann Whitney tests for continuous variables with non-normal distribution. We constructed three indicator variables representing years 2012, 2013, and 2014, leaving 2011 as the reference. We did logistic regressions including these indicators for time as key explanatory variables, while adjusting for patients' ACS types (unstable angina, NSTEMI, STEMI), demographics (age and sex), comorbidities (hypertension, hyperlipidemia, diabetes mellitus, COPD, current smoking, heart failure, renal failure, under dialysis, prior cerebrovascular disease, prior peripheral vascular disase, prior PCI, prior cardiac valve surgery, prior CABG). The dependent variable was in-hospital death. We also tested the linear trend over time in the models. We report odds ratios (ORs) and 95% CIs from the multilevel logistic regression related to the year indicators. All comparisons were 2-sided, with statistical significance defined as $P< 0.05$. Statistical analyses were performed using GraphPad Prism, version 6.01 and SAS software, version 9.3.

Patient and Public Involvement Patients and public were not involved in this study.

Results

A total of 144 659 ACS patients undergoing PCI in 117 military hospitals were recruited into this

study from 2011 to 2014, located in all 7 geographic regions of mainland China, including North China (n = 25), Northwest (n = 14), Northeast (n = 10), East China (n = 29), Southwest (n = 14), Central China (n = 12), and South China (n = 13). Of these, 82 hospitals provided 140 374 cases (97.0%) across all the study years (Table S1). In brief, only 20 (17.1%) hospitals performed more than 400 PCIs on ACS patients annually (Figure 1A), and these hospitals performed 71.9% PCIs (104 026 cases) during 2011-2014 (Figure 1B). Geographically, although the total number of hospitals in Northern China (North China, Northwest, Northeast regions) was less than that in Southern China (South China, East China, Central China, and Southwest regions), there were more military hospitals in Northern China performed PCI procedures > 400 cases per year than those in Southern China (Figure 1C), and northern military hospitals performed the majority of PCIs during the study years (66.5%) (Figure 1D).

Generally, the number of ACS patient undergoing PCI has increased by 27.8%, while the proportions of most comorbidities of these patients had concordant decrease over time. Hospitals in northern China (North China, Northwest, and Northeast) performed the majority of PCIs, with most patients being civilian and with Han ethnicity. There were significant increases in the proportions of patients diagnosed as UAP, of civilian identity, male gender, treated in hospitals in Northeast, East and South China, and significant decreases in the proportions of patients diagnosed as STEMI, treated in hospitals in North China, Northwest and Central China (Table 1). During 2013-2014, only half of these patients were covered by urban resident medical service (53.4% to 53.6%) (Table S2).

Table 1. Baseline characteristics of ACS patients undergoing PCI during 2011-2014

	2011		2012		2013		2014		*P* value
	n	%	n	%	n	%	n	%	for trend
ACS	30800		34974		39524		39361		
UAP	22038	71.6	24847	71.0	28727	72.7	28508	72.4	< .0001
STEMI	6514	21.1	7302	20.9	7889	20.0	7856	20.0	< .0001
NSTEMI	2248	7.3	2825	8.1	2908	7.4	2997	7.6	.87
Age, years	30651		34872		39466		39351		

18-24	12	0.0	8	0.0	16	0.0	15	0.0	.70
25-34	177	0.6	223	0.6	246	0.6	243	0.6	.62
35-44	1597	5.2	1930	5.5	2149	5.4	2187	5.6	.09
45-54	5849	19.1	6663	19.1	7283	18.5	7507	19.1	.52
55-64	10291	33.6	11990	34.4	13888	35.2	13381	34.0	.11
65-74	8615	28.1	9510	27.3	10650	27.0	10832	27.5	.09
75-84	3850	12.6	4227	12.1	4884	12.4	4800	12.2	.33
>84	260	0.8	321	0.9	350	0.9	386	1.0	.11
Gender	30155		34191		39189		39336		
Male	22017	73.0	25423	74.4	29104	74.3	29193	74.2	< .01
Female	8138	27.0	8768	25.6	10085	25.7	10143	25.8	
Ethnicity	30800		34974		39524		39361		
Han	30589	99.3	34691	99.2	38974	98.6	38620	98.1	< .0001
Others	211	0.7	283	0.8	550	1.4	741	1.9	
Region of hospital	30783		34970		39524		39361		
North China	9156	29.7	9631	27.5	9914	25.1	11086	28.2	< .0001
Northwest	7632	24.8	7939	22.7	9728	24.6	7821	19.9	< .0001
Northeast	3924	12.7	5347	15.3	6691	16.9	7284	18.5	< .0001
East China	3742	12.2	4630	13.2	5053	12.8	5241	13.3	< .001
Southwest	3515	11.4	4346	12.4	4877	12.3	4549	11.6	.96
Central China	1977	6.4	1928	5.5	1910	4.8	1944	4.9	< .0001
South China	837	2.7	1149	3.3	1351	3.4	1436	3.6	< .0001
Comorbidities	30800		34974		39524		39361		
Hypertension	17600	57.1	19942	57.0	21260	53.8	21701	55.1	< .0001
Hyperlipidemia	6844	22.2	7774	22.2	7420	18.8	7330	18.6	< .0001
Diabetes Mellitus	6829	22.2	7817	22.4	8394	21.2	8819	22.4	.75
COPD	541	1.8	448	1.3	478	1.2	447	1.1	< .0001
Current smoking	9093	29.5	10838	31.0	11467	29.0	10568	26.8	< .0001
Heart failure*	1378	4.5	1373	3.9	1331	3.4	1122	2.9	< .0001
Renal failure*	277	0.9	297	0.8	259	0.7	276	0.7	< .001
Under dialysis*	34	0.1	52	0.1	45	0.1	45	0.1	.71
Prior MI	7560	24.5	7828	22.4	7928	20.1	5648	14.3	< .0001
Prior CVD	2014	6.5	1912	5.5	1990	5.0	2018	5.1	< .0001
Prior PVD	457	1.5	430	1.2	489	1.2	515	1.3	.09
Prior PCI	5702	18.5	6125	17.5	6467	16.4	5973	15.2	< .0001
Prior CVS	1077	3.5	1192	3.4	563	1.4	14	0.0	< .0001
Prior CABG	936	3.0	952	2.7	580	1.5	204	0.5	< .0001
Familial CAD	805	2.6	867	2.5	681	1.7	615	1.6	< .0001

ACS, acute coronary syndrome; CABG, coronary artery bypass graft; CAD, coronary artery disease; COPD, chronic obstructive pulmonary disease; CVD, cerebrovascular disease; CVS, cardiac valve surgery; MI, myocardial infarction; NSTEMI, non-ST elevation myocardial infarction; PCI, percutaneous coronary intervention; PVD, peripheral vascular disease; STEMI, ST elevation myocardial infarction; UAP, unstable angina pectoris; * assessed and recorded at admission.

The proportion of primary PCI dropped significantly in ACS patients in all categories. In STEMI

patients, the fraction of primary PCI in all PCI performed did not change dramatically (44.0% to 47.9%, Table 2). There is remarkable increase in the proportion of anterior myocardial infarction and significant decrease in the proportion of cardiac function defined as Killip III/IV (Table S3). There was more time delay on first medical contact to balloon dilation in 2014 than in 2013 (median 50 *vs* 40, *P*< .01) (Table S4). PCI procedures done through the radial artery had increased markedly from 72% in 2011 to 90.4% in 2014. The use of clopidogrel and GP IIb/IIIa inhibitor dropped significantly. Proportions of novel drugs like ticagrelor and bivalirudin, and of assisted devices such as intra-aortic balloon pump (IABP), intravascular ultrasound (IVUS), optical coherence tomography (OCT), and fractional flow reserve (FFR) measurement, were low in all time periods (Table 2, Table S5). In addition, from 2013-2014, thrombolysis in STEMI patients was not altered in terms of performance rate, thrombolytics, and time delay from angina to thrombolysis increased remarkably and the success rate dropped significantly as well (Table S6).

Table 2. Perioperative characteristics of ACS patients undergoing PCI during 2011-2014

	2011		2012		2013		2014		*P* value
	n	%	n	%	n	%	n	%	for trend
pPCI	30800		34974		39524		39361		
Yes	3689	12.0	4359	12.5	4263	10.8	4211	10.7	< .0001
On STEMI	2866	9.3	3499	10.0	3505	8.9	3544	9.0	< .01
pPCI/PCI	2866/6514	44.0	3499/7302	47.9	3505/7889	44.4	3544/7856	45.1	.78
On NSTEMI	334	1.1	372	1.1	349	0.9	365	0.9	< .01
On UAP	489	1.6	488	1.4	409	1.0	302	0.8	< .0001
No	27111	88.0	30615	87.5	35261	89.2	35150	89.3	
Access artery	30800		34800		39524		39361		
Radial	22171	72.0	28266	81.2	34520	87.3	35582	90.4	< .0001
Femoral	8453	27.4	6527	18.7	4803	12.2	3545	9.0	< .0001
Brachial	165	0.5	170	0.5	187	0.5	209	0.5	.94
Others	11	0.0	11	0.0	14	0.0	25	0.1	.06
Contrast type	30080		34154		38585		39361		
Nonionic	30027	99.8	34119	99.9	38493	99.8	39198	99.6	< .0001
Iso-osmolar	10055	33.4	12988	38.0	16540	42.9	20034	50.9	< .0001
Low-osmolar	19972	66.4	21131	61.9	21953	56.9	19164	48.7	< .0001
Ionic	53	0.2	35	0.1	92	0.2	163	0.4	< .0001

Antiplatelet	30800		34974		39524		39361		
Aspirin	29459	95.6	34189	97.8	38267	96.8	38547	97.9	< .0001
Clopidogrel	29486	95.7	34231	97.9	37165	94.0	36122	91.8	< .0001
Ticagrelor	30	0.1	13	0.0	222	0.6	1299	3.3	< .0001
Ticlopidine	54	0.2	50	0.1	520	1.3	1202	3.1	< .0001
Cilostazol	22	0.1	17	0.0	23	0.1	15	0.0	.11
GP IIb/IIIa inhibitor	4670	15.2	6232	17.8	6135	15.5	5099	13.0	< .0001
Anticoagulation	30800		34974		39524		39361		
UFH	18788	61.0	21343	61.0	22885	57.9	24547	62.4	.19
LMWH	9248	30.0	10398	29.7	12622	31.9	12012	30.5	< .01
Fondaparinux	373	1.2	939	2.7	886	2.2	0	0.0	< .0001
Bivalirudin	0	0.0	0	0.0	93	0.2	395	1.0	< .0001
IABP	30800		34974		39524		39361		
Yes	450	1.5	579	1.7	584	1.5	432	1.1	< .0001
No	30350	98.5	34395	98.3	38940	98.5	38929	98.9	
IVUS	30800		34974		39524		39361		
Yes	439	1.4	399	1.1	383	1.0	439	1.1	< .0001
No	30361	98.6	34575	98.9	39141	99.0	38922	98.9	

ACS, acute coronary syndrome; GP IIb/IIIa, glycoprotein IIb/IIIa; IABP, intra-aortic balloon pump; IVUS, intravascular ultrasound; LMWH, low molecular weight heparin; NSTEMI, non-ST elevation myocardial infarction; PCI, percutaneous coronary intervention; pPCI, primary percutaneous coronary intervention; STEMI, ST elevation myocardial infarction; UAP, unstable angina pectoris; UFH, unfractionated heparin.

Under catheterization, artery stenosis > 75% increased significantly in proportions during the study years. Long lesion constitutes approximately one third of the overall lesions, there were increased trends in the proportion of general lesion, total occluded lesion, and thrombus lesion, and decreased trends in long lesion, calcified lesion and bifurcation lesion. The proportion of triple-vessel lesion significantly decreased, while that of solitary vessel lesion increased dramatically. Under PCI, target vessels were primarily solitary with increased trends in proportions of all arteries, followed by double vessels with decreased proportions. Target vessels involving LM consist 3.4% to 4.2% of all PCI procedures. PCI procedures targeting triple vessels had also decreased both in amount and in proportion(Table 3). From 2013 to 2014, the mean implanted stent per patient decreased from 1.5 to 1.4 (P< .01) (Table S7), the majorities implanted stents were made by domestic companies with a decreased proportion over time (Table S8).

Table 3. PCI characteristics of ACS patient during 2011-2014

	2011		2012		2013		2014		*P* value
	n	%	n	%	n	%	n	%	for trend
Artery stenosis	39090		42260		46915		46938		
75-99%	27879	71.3	31048	73.5	34976	74.6	35971	76.6	< .0001
100%	7228	18.5	8642	20.4	9704	20.7	9385	20.0	< .0001
50-75%	3557	9.1	2326	5.5	2003	4.3	1540	3.3	< .0001
< 50%	426	1.1	244	0.6	232	0.5	42	0.1	< .0001
Lesion category	38606		41713		46292		46073		
Long lesion[#]	13571	35.2	14939	35.8	16375	35.4	15736	34.2	< .001
General lesion	12686	32.9	13036	31.3	14874	32.1	15878	34.5	< .0001
Total occluded lesion	4597	11.9	5532	13.3	6058	13.1	5930	12.9	< .001
Calcified lesion	3184	8.2	3006	7.2	3473	7.5	2781	6.0	< .0001
Bifurcation lesion	2545	6.6	2463	5.9	2479	5.4	2891	6.3	< .01
Thrombus lesion	1782	4.6	2469	5.9	2711	5.9	2549	5.5	< .0001
Small vessel[##]	217	0.6	246	0.6	277	0.6	272	0.6	.59
Bypass graft lesion	24	0.1	22	0.1	45	0.1	36	0.1	.12
Lesion vessel[*]	30457		34800		39427		39295		
Triple	12298	40.4	12803	36.8	13253	33.6	12301	31.3	< .0001
Solitary	8580	28.2	11567	33.2	14395	36.5	14912	37.9	< .0001
LAD	5397	17.7	7090	20.4	8544	21.7	8599	21.9	< .0001
RCA	2147	7.0	3111	8.9	3866	9.8	4222	10.7	< .0001
LCX	1036	3.4	1366	3.9	1985	5.0	2038	5.2	< .0001
Double	7308	24.0	8104	23.3	9180	23.3	9374	23.9	.84
LAD + RCA	3694	12.1	3936	11.3	4270	10.8	4285	10.9	< .0001
LAD + LCX	2558	8.4	2968	8.5	3475	8.8	3554	9.0	< .001
LCX + RCA	1056	3.5	1200	3.4	1435	3.6	1535	3.9	< .001
Triple + LM	1540	5.1	1481	4.3	1638	4.2	1644	4.2	< .0001
Double + LM	489	1.6	502	1.4	574	1.5	593	1.5	.41
LAD + LCX + LM	230	0.8	247	0.7	339	0.9	315	0.8	.16
LAD + RCA + LM	195	0.6	212	0.6	198	0.5	215	0.5	< .05
LCX + RCA + LM	64	0.2	43	0.1	37	0.1	63	0.2	.09
Solitary + LM	178	0.6	253	0.7	300	0.8	367	0.9	< .0001
LAD + LM	139	0.5	197	0.6	220	0.6	281	0.7	< .0001
RCA + LM	26	0.1	37	0.1	51	0.1	49	0.1	.09
LCX + LM	13	0.0	19	0.1	29	0.1	37	0.1	< .01
LM	64	0.2	90	0.3	107	0.3	128	0.3	< .01
Target vessel[*]	28278		32836		38176		39224		
Solitary	20801	73.6	25513	77.7	30592	80.1	31456	80.2	< .0001
LAD	10735	38.0	13277	40.4	15749	41.3	15960	40.7	< .0001
LCX	3017	10.7	3563	10.9	4665	12.2	4867	12.4	< .0001
RCA	7049	24.9	8673	26.4	10178	26.7	10629	27.1	< .0001
Double	5713	20.2	5685	17.3	5906	15.5	5886	15.0	< .0001
LAD + LCX	2723	9.6	2683	8.2	2865	7.5	2815	7.2	< .0001

LAD + RCA	1978	7.0	1937	5.9	1904	5.0	1932	4.9	< .0001
LCX + RCA	1012	3.6	1065	3.2	1137	3.0	1139	2.9	< .0001
Solitary + LM	566	2.0	603	1.8	690	1.8	923	2.4	< .001
LAD + LM	482	1.7	531	1.6	600	1.6	782	2.0	< .01
LCX + LM	68	0.2	58	0.2	71	0.2	123	0.3	< .05
RCA + LM	16	0.1	14	0.0	19	0.0	18	0.0	.68
Double + LM	483	1.7	455	1.4	462	1.2	464	1.2	< .0001
LAD + LCX + LM	405	1.4	375	1.1	387	1.0	382	1.0	< .0001
LAD + RCA + LM	73	0.3	69	0.2	69	0.2	72	0.2	< .05
LCX + RCA + LM	5	0.0	11	0.0	6	0.0	10	0.0	.92
Triple	568	2.0	433	1.3	354	0.9	298	0.8	< .0001
LM	97	0.3	113	0.3	153	0.4	173	0.4	< .05
Triple + LM	50	0.2	34	0.1	19	0.0	24	0.1	< .0001

ACS, acute coronary syndrome; LAD, left anterior descending artery; LCX, left circumflex artery; LM, left main artery; PCI, percutaneous coronary intervention; RCA, right coronary artery; # denotes length of lesion > 20mm; ## denotes vessel diameter < 2.5mm; * include anomalous artery, intermediate artery, and vessel graft.

In general, more complications were recorded during PCI than post-PCI, and the overall complications were significantly decreased both in amount and in proportion, either during PCI or post-PCI. During PCI procedures, slow flow, serious dissection, acute thrombosis, perforation, and cardiac tamponade had markedly decreased. As for complications after PCI, acute/subacute stent thrombosis, organ failure, major bleeding/hematoma, contrast reaction, and thromboembolism had decreased trends in proportion during the study years. There were also significantly decreased trends of death both in amount and in proportion, during/after PCI, with the majority of death found after PCI procedures due to cardiogenic triggers (Table 4). After adjustment for patient demographic and clinical characteristics in the multilevel logistic regression, the risk of in-hospital mortality also significantly decreased over time (Figure 2).

Table 4. In-hospital adverse events of ACS patient undergoing PCI during 2011-2014

	2011 (n = 30800)		2012 (n =34974)		2013 (n = 39524)		2014 (n = 39361)		*P* value for trend
	n	‰	n	‰	n	‰	n	‰	
Complication	496	16.1	539	15.4	429	10.9	256	6.5	< .0001
During procedure*	342	11.1	334	9.5	269	6.8	151	3.8	< .0001
Slow flow	201	6.5	168	4.8	159	4.0	87	2.2	< .0001
Serious dissection	71	2.3	75	2.1	64	1.6	32	0.8	< .0001

Acute thrombosis	54	1.8	48	1.4	36	0.9	23	0.6	< .0001
Perforation	22	0.7	32	0.9	17	0.4	17	0.4	< .05
Cardiac tamponade	11	0.4	17	0.5	9	0.2	7	0.2	< .05
Acute occlusion	11	0.4	24	0.7	19	0.5	12	0.3	.38
Post-procedure	154	5.0	205	5.9	160	4.0	105	2.7	< .0001
Acute/subacute ST	46	1.5	49	1.4	37	0.9	30	0.8	< .001
Organ failure	37	1.2	31	0.9	29	0.7	19	0.5	< .001
Organ support	8	0.3	2	0.0	7	0.2	3	0.0	.15
Major bleeding/hematoma	19	0.6	19	0.5	23	0.6	6	0.2	< .01
Organ bleeding	14	0.5	21	0.6	11	0.3	11	0.3	.06
Postoperative MI	10	0.3	20	0.6	14	0.4	7	0.2	.10
Contrast reaction	7	0.2	10	0.3	3	0.0	2	0.0	< .01
Postoperative infection	5	0.2	6	0.2	8	0.2	3	0.0	.40
Thromboembolism	4	0.1	11	0.3	2	0.0	2	0.0	< .05
Emergent surgery	4	0.1	2	0.0	1	0.0	2	0.0	.18
Others	28	0.9	56	1.6	43	1.1	26	0.7	.06
Death	166	5.4	179	5.1	150	3.8	113	2.9	< .0001
During PCI	41	1.3	30	0.9	22	0.6	16	0.4	< .0001
Cardiogenic									
Yes	34	1.1	25	0.7	16	0.4	16	0.4	< .0001
No	1	0.0	1	0.0	2	0.0	0	0.0	.52
Uncertain	6	0.2	4	0.1	4	0.1	0	0.0	< .05
PCI related									
Yes	4	0.1	1	0.0	1	0.0	4	0.1	.76
No	23	0.7	15	0.4	11	0.3	11	0.3	< .01
Uncertain	14	0.5	14	0.4	10	0.3	1	0.0	< .001
Post-PCI	125	4.1	149	4.3	128	3.2	97	2.5	< .0001
Cardiogenic									
Yes	102	3.3	108	3.1	108	2.7	82	2.1	< .01
No	10	0.3	22	0.6	8	0.2	9	0.2	.08
Uncertain	13	0.4	19	0.5	12	0.3	6	0.2	< .05
PCI related									
Yes	4	0.1	5	0.1	7	0.2	8	0.2	.40
No	88	2.9	120	3.4	100	2.5	80	2.0	< .01
Uncertain	33	1.1	24	0.7	21	0.6	9	0.2	< .0001

ACS, acute coronary syndrome; MI, myocardial infarction; PCI, percutaneous coronary intervention; ST, stent thrombosis.

Discussion

To the best of our knowledge, this is the first large, nationwide study of ACS patients undergoing PCI in Chinese military hospitals. Compared with contemporary developed country such as the U.S., the proportion of hospitals capable of performing PCIs more than 400 cases was substantially low (17.1%

vs 41.5% in U.S.).[19] Accordingly, the application rates of assisted devices were also low, such as IABP (1.1% to 1.7%), temporary pacemaker (1.9% to 2.4%), IVUS (1.0% to 1.4%), OCT (0.1%), and FFR measurement (0.1% to 0.5%), as these support is available with experienced interventional cardiologists and skilled support staff in high-volume well-equipped facilities. Out data also suggest great regional disparities of PCI procedures performed on ACS patients, with patients in the north region of China (North China, Northwest, and Northeast) consumed the majority of interventional resources (65.5%-67.2% of all PCI cases for ACS patients, Table1). This also reflects pandemic state of unstable coronary artery disease in these regions.[20-22] In this regard, medical resources shall be prioritized to better serve disparate needs in different regions, especially the north region of China. Furthermore, the health care coverage system in contemporary China is also concerning, as during 2013-2014 only 53.4% to 53.6% ACS patients were covered under urban resident medical service with high reimbursement rate, while 20.1% to 22.1% patients were covered under new rural cooperative medical service with low reimbursement rate, and 16.3% to 17.2% patients were uncovered.[23-25] Given the great economic burdens ACS patients bear on PCI procedures and medications during hospitalization and thereafter,[26-28] the current medical coverage patterns shall be optimized to improve the quality of life for these patients as well as their families. Nevertheless, the overall decreased trends in proportions of comorbidities suggest the effectiveness of cardiovascular related disease control during 2011-2014 in China.

Primary PCI was performed with high prevalence in hospitals of developed countries. For example, in a recent nationwide Belgian STEMI registry during 2009-2013, 89.6% of STEMI patients underwent primary PCI.[29] In the U.S. NCDR 2010-2011 report, the primary PCI consisted 84.8% of all PCI performed for STEMI patients.[30] However, the proportion of primary PCI performed on STEMI

patients was still very low in this study, and this proportion did not change significantly over time (44.0% in 2011 to 45.1% in 2014). This could be explained by the low proportion of high-volume PCI-capable hospitals in China, as these hospitals are well-equipped with experienced interventional cardiologists and skilled support staff, which are all required for the successful implementation of primary PCI. Nevertheless, median time delay of first medical contract (FMC) to balloon dilation for primary PCIs done with STEMI patients during 2013-2014 were 50 minutes, which were far below the guideline-recommended threshold of 90 minutes.[31] This important quality improvement might be catalyzed by the awareness of the performance metric for participating hospitals, as study demonstrated that patients treated in hospitals that had been enrolled in the D2B Alliance for > 3 months were significantly more likely to have D2B times of < 90 minutes than patients treated in non-enrolled hospitals.[32] In this regard, the scenario of D2B time in real world practice might be less satisfying, as performance metrics were largely unmonitored. Furthermore, given that time delay of angina onset to FMC was still huge (median 270 minutes), great efforts are still needed to promote broader initiatives at a systems level to reduce total ischemic time, which was shown as the principal determinant of outcome.[33,34] These efforts might include patient education, improvements in emergent medical service and emergent department care, establishment of networks of non-PCI-capable and PCI-capable hospitals, and work with policy makers to implement healthcare system reform.[35-41]

The current study depicted several notable changes as compared with the former China PEACE study. In their study, Xin Zheng and colleagues reported dramatic increase of the adoption of radial artery access from 3.5% to 79.0% in the practice of interventional cardiology in China during 2001-2011.[6] In this study of ACS patients, the trend is still rising, with 72.0% PCI procedures accessed via radial artery in 2011 to 90.4% in 2014, compared with 10.9% cases/procedures performed by means

of a radial approach in 2011 to 25.2% in 2014 in the United States [NCDR]. Also, the China PEACE-Retrospective CathPCI Study group reported that the proportions of patients who received a glycoprotein IIb/IIIa inhibitor and clopidogrel both increased from 2001 to 2011 in non-military hospitals in China.[6] Unlike their findings, in our study, the proportions of clopidogrel and glycoprotein IIb/IIIa inhibitor both decreased significantly (95.7% to 91.8% and 15.2% to 13.0%, respectively), it might suggest different patterns of medications between non-military hospitals and military hospitals in the field of interventional cardiology, or just be a result of rapidly evolved medical practice in all hospitals in contemporary China, possibly due to the emergence of novel P2Y12 inhibitor ticagrelor and novel anticoagulant bivalirudin in China. Meanwhile, operators implanted less stents per patient in 2014 than in 2013 (mean 1.4 *vs* 1.5), which was also remarkably less than those implanted during 2001-2011 in China PEACE study (mean 1.4 in 2001, 1.7 in 2006, and 1.8 in 2011).[6] This may be as a result of the enforcement of quality improvement initiatives during 2011-2014 by the Quality Control Center of Intervention for Cardiovascular Diseases.[7] Finally, although domestic-made stents consist the majority of stents used during PCI procedures, their proportion dropped significantly (65.1% in 2013 to 61.8% in 2014), which was quite different from the scenario of dramatic increase of domestic stents used in non-military hospitals in China PEACE study during 2001-2011 (1.6% in 2001 to 74.8% in 2011).[6]

In a recent meta-analysis of large, high-quality, contemporary randomized studies comparing radial and femoral access in invasively managed patients with ACS, radial access was found to reduce mortality, major adverse cardiovascular events, and major bleeding.[42] Similarly, with the rising adoption of radial access from 2011 to 2014 in this study, the proportion of major bleeding or hematoma after PCI and in-hospital mortality were both significantly decreased over time. In this

regard, transradial access shall be advocated in countries that use it less frequently.

Compared with data reported from the NCDR (National Cardiovascular Data Registry) in the U.S. during 2010-2011,[30] uses of ticagrelor and bivalirudin were extremely low for ACS patients undergoing PCI during 2011-2014 (less than 3.3% and 1.0%, respectively), although their proportions were rising. This might be explained by the delayed introduction of these drugs into Chinese pharmaceutical market, as well as uncovered status under the drug list of Medical Service in China. Given the great superiorities of these novel antiplatelet and anticoagulation drugs,[1,43] coordinated advocacy efforts are needed to work with policy makers to include these drugs into the list for coverage, to improve the quality of care for ACS patients and the outcomes of PCI procedures. Nevertheless, our data demonstrated great improvement in the quality metrics of PCI procedures during the study years. The proportion of non-obstructive CAD (stenosis < 50%) was 1.1% in 2011. Although the proportion is much higher than that reported in NCDR during 2010 to 2011 (0.2%), it has dropped substantially to 0.1% in 2014. Out study also revealed dramatic changes in the pattern of the extent of CAD, with the dominance of 3-vessel disease in 2011 (40.4%) shifted to the dominance of 1-vessel disease in 2014 (37.9%) and no obvious change in 2-vessel disease (23.3% to 24.0%). This trend was quite different with distributions found in patients undergoing PCI in the U.S. during 2010-2011 (38.1%, 32.6%, and 39.1% for 1-, 2-, and 3-vessel disease, respectively).[30] In treated lesion vessels, although there were remarkable increase of 1-vessel disease and significant decreases of 2-and 3-vessel diseases in proportions, interventional operators in Chinese military hospitals still treated lower proportion of 1-vessel disease and higher proportion of 2-vessel disease in 2014 than peers in the U.S. during 2010-2011 (80.2% *vs* 86.2% and 15.0% *vs* 12.8%, respectively).[30] Of note, the proportion of treated vessels involving left main artery (3.4% to 4.2%) was significantly higher than proportions reported in

the U.S. during 2010-2011(1.8%)[21] as well as in Chinese non-military hospitals during 2001-2011 (0.4%-2.1%) in China PEACE study.[6] The facts that considerable amount of grade 0-2 TIMI flow before PCI almost disappeared after PCI suggest high quality of performance of PCI procedures. Especially, compared with data in 2013, higher proportions of grade 0 and 1 TIMI flow before PCI turned to higher proportion of grade 3 TIMI flow after PCI in 2014, suggesting the quality of performance was still improving. The relatively low and decreasing rate of overall complications (1.6% in 2011 to 0.7% in 2014) and death (0.5% in 2011 to 0.3% in 2014) for PCI procedures might be attributable to the decrease of worse cardiac function over time (patients with Killip III-IV grades decreased significantly from 2011-2013, Table S3). On the other hand, the consistent low rates are also suggestive of good performance of cardiac intervention on these patients.

Some limitations of this study should be noted. First, the partial revision of the registry form in 2013 has made comparisons of some critical measures impossible during 2011-2014 consecutively. However, the purpose of the necessary revision was to reflect contemporary changes in the practice of cardiac intervention during the study years. And we analyzed all critical measures provided they were available. Second, due to the gigantic number of nationwide enrolled patients and limit of sufficient funding and other resources, we only compared the in-hospital outcomes for the patients. However, it's possible to follow up the long-term outcomes for these patients, given that contact information of most patients were collected. Third, in this study comparisons of data with other studies were not matched exactly both temporally and categorically, as to the best of our knowledge, the same large scale, nationwide registries of acute coronary syndromes during the same study period were not available. Nevertheless, we believe this study has given an updated and comprehensive overview of contemporary practice of interventional cardiology in military hospitals in China.

CONCLUSION

This study outlined the general profiles of cardiac intervention practice in contemporary military hospital in China. Our data revealed the overall interventional resources were still limited in military hospitals, with great disparities of resources and consumptions in different geographical regions across China, and major gaps still exist in optimal medical coverage for ACS patients. Other than data from non-military hospitals, our findings can serve as an indispensable addition to a comprehensive overview of the practice of cardiac intervention in China.

Contributors RZ participated in the data collection an drafted the manuscript. KX participated in the data collection and design of the study. YL, QM and YH participated in the design of the study and undertook statistical analyses. All authors were involved in writing the paper and had final approval of the submitted and published versions.

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Competing interests None declared.

Ethics approval This study was approved by the ethics committee of the General Hospital of Shenyang Military Region. The requirement of informed consent was waived due to the nature of the retrospective study. All participating hospitals accepted the ethics committee approval.

Data sharing statement No additional data are available.

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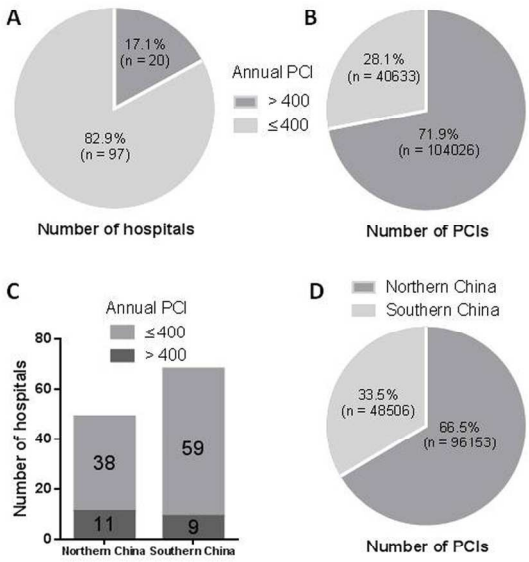
Figure Legends

Figure 1. Overall and regional distributions of PCI-capable military hospitals and PCI procedures performed.

Military hospitals were divided by their annual PCI volume with a threshold of 400 cases per year (A), as well as further by geographical regions (C); The overall PCI procedures performed during 2011-2014 were also grouped by annual PCI volumes of hospitals (B), and by regions (D). Northern China include North China, Northwest China and Northeast China, Southern China include South China, East China, Central China, and Southwest China.

Figure 2. Adjusted in-hospital mortality for ACS patients undergoing PCI.

Adjusted odds ratio of 1 shows no difference from year 2011. We included 143063 patients (30202 in 2011, 34304 in 2012, 39206 in 2013, and 39351 in 2014).



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190x142mm (300 x 300 DPI)

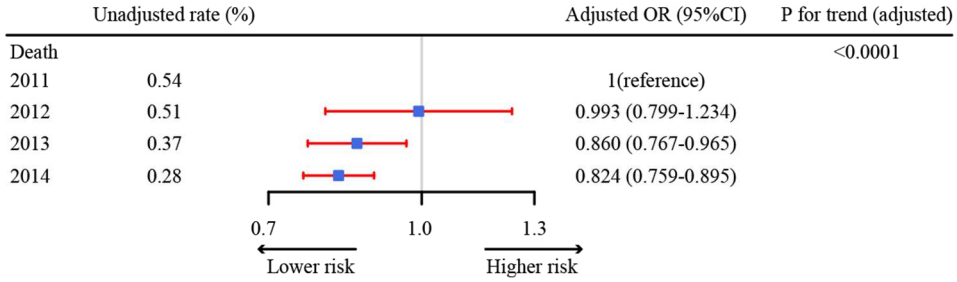

Figure 2. Adjusted in-hospital mortality for ACS patients undergoing PCI./Adjusted odds ratio of 1 shows no difference from year 2011. We included 143063 patients (30202 in 2011, 34304 in 2012, 39206 in 2013, and 39351 in 2014).

105x30mm (300 x 300 DPI)

Table S1. Distribution of ACS patients undergoing PCI in participated hospitals during 2011-2014

Hospital	Region	2011	2012	2013	2014
General Hospital of Shenyang Military Region	Northeast	3118	4198	5597	6103
The 463 Hospital	Northeast	224	332	250	374
The 210 Hospital	Northeast	190	197	211	207
The 313 Hospital	Northeast	130	237	305	277
The 202 Hospital	Northeast	115	139	111	154
The 208 Hospital	Northeast	80	113	77	48
The 211 Hospital	Northeast	59	73	71	50
The 201 Hospital	Northeast	7	33	20	10
The 205 Hospital	Northeast	1	25	47	61
General Hospital of Jilin PAP Corps	Northeast	0	0	2	0
General Hospital of PLA	North China	2094	1993	1782	2562
The Affiliated Hospital of PAP College of Logistics	North China	1602	1324	1355	1391
Bethune International Peace Hospital	North China	927	855	1009	950
General Hospital of PAP	North China	859	753	757	974
The 252 Hospital	North China	675	749	848	933
General Hospital of Navy	North China	482	667	623	791
The 304 Hospital	North China	398	502	263	254
The 254 Hospital	North China	391	166	158	258
The 309 Hospital	North China	312	376	435	295
The General Hospital of Beijing Military Region	North China	240	372	408	488
The Second Artillery General Hospital	North China	236	188	215	181
General Hospital of Air Force	North China	218	221	293	407
The 305 Hospital	North China	213	257	429	492
The 306 Hospital	North China	192	367	386	368
The 307 Hospital	North China	125	137	126	102
The 264 Hospital	North China	75	101	142	177
The 261 Hospital	North China	68	59	43	48
The 251 Hospital	North China	49	5	97	0
The 263 Hospital	North China	0	0	21	48
The 285 Hospital	North China	0	59	100	67
The 464 Hospital	North China	0	86	139	70
The Second Hospital of Beijing PAP Corps	North China	0	34	13	30
General Hospital of Beijing PAP Corps	North China	0	35	37	33
General Hospital of Hebei PAP Corps	North China	0	89	56	5
General Hospital of Shanxi PAP Corps	North China	0	236	179	162
Changhai Hospital of SMMU	East China	750	1206	1320	1828
General Hospital of Nanjing Military Region	East China	581	621	470	486
General Hospital of Jinan Military Region	East China	472	393	267	335
Changzheng Hospital of SMMU	East China	337	362	499	375
The 88 Hospital	East China	209	193	168	135
The 148 Hospital	East China	186	203	166	165

The 105 Hospital	East China	164	70	64	152
The 401 Hospital	East China	162	144	92	33
The 97 Hospital	East China	162	197	260	194
Fuzhou General Hospital of PLA	East China	158	196	344	272
Anqing Hospital of Navy	East China	91	62	59	74
The 101 Hospital	East China	71	96	107	114
The 89 Hospital	East China	67	46	68	62
The 107 Hospital	East China	65	113	181	40
The 171 Hospital	East China	59	70	105	72
The 404 Hospital	East China	50	98	73	78
The 94 Hospital	East China	41	68	84	116
The 411 Hospital	East China	37	38	53	64
The 174 Hospital	East China	24	120	91	88
The 180 Hospital	East China	19	65	122	136
The 85 Hospital	East China	11	45	52	24
The 98 Hospital	East China	10	9	10	42
The 117 Hospital	East China	9	18	16	20
General Hospital of Zhejiang PAP Corps	East China	7	71	70	47
The 123 Hospital	East China	0	42	70	54
The 175 Hospital	East China	0	18	117	91
The 456 Hospital	East China	0	6	6	10
The 92 Hospital	East China	0	49	102	112
General Hospital of Fujian PAP Corps	East China	0	11	17	22
General Hospital of Guangzhou Military Region	South China	685	830	830	713
The 181 Hospital	South China	54	55	56	44
The 303 Hospital	South China	49	7	48	62
The 458 Hospital	South China	32	32	97	78
The 163 Hospital	South China	17	57	42	13
The 169 Hospital	South China	0	7	5	3
General Hospital of Guangdong PAP Corps	South China	0	112	211	195
General Hospital of Hunan PAP Corps	South China	0	49	44	22
The 425 Hospital	South China	0	0	18	0
The 187 Hospital	South China	0	0	0	40
The 422 Hospital	South China	0	0	0	104
The 425 Hospital	South China	0	0	0	16
Hainan Hospital of General Hospital of PLA	South China	0	0	0	146
Wuhan General Hospital of PLA	Central China	482	394	482	462
The 150 Hospital	Central China	460	244	124	484
The 91 Hospital	Central China	371	479	465	270
The 153 Hospital	Central China	183	180	76	93
The 371 Hospital	Central China	153	170	216	48
General Hospital of Henan PAP Corps	Central China	145	91	142	52
The 152 Hospital	Central China	70	62	39	89
The 155 Hospital	Central China	47	132	132	147

The 161 Hospital	Central China	47	77	66	76
The 159 Hospital	Central China	19	38	67	23
General Hospital of Hubei PAP Corps	Central China	0	61	101	75
The 477 Hospital	Central China	0	0	0	125
Xijing Hospital of FMMU	Northwest	4438	4514	5456	5326
Tangdu Hospital of FMMU	Northwest	998	1287	1749	325
General Hospital of Lanzhou Military Region	Northwest	762	685	784	749
Urumchi General Hospital of PLA	Northwest	469	489	623	617
General Hospital of Shannxi PAP Corps	Northwest	452	362	415	166
The 451 Hospital	Northwest	182	157	181	125
The 3 Hospital	Northwest	105	86	84	47
The 474 Hospital	Northwest	94	113	157	175
The 323 Hospital	Northwest	74	105	109	97
The 273 Hospital	Northwest	58	57	95	113
The 18 Hospital	Northwest	0	4	9	20
General Hospital of Ningxia PAP Corps	Northwest	0	48	38	9
General Hospital of Xinjiang PAP Corps	Northwest	0	32	28	33
The 1 Hospital	Northwest	0	0	0	19
Kunming General Hospital of PLA	Southwest	926	878	1102	993
Xinqiao Hospital of TMMU	Southwest	816	1130	1125	1393
Southwest Hospital of TMMU	Southwest	790	903	863	364
Daping Hospital of TMMU	Southwest	602	742	846	820
The General Hospital of Chengdu Military Region	Southwest	237	543	748	733
The 452 Hospital	Southwest	79	53	42	81
The 59 Hospital	Southwest	42	47	44	34
Tibet General Hospital of PLA	Southwest	23	0	0	0
The 324 Hospital	Southwest	0	0	21	29
The 37 Hospital	Southwest	0	15	4	19
The 44 Hospital	Southwest	0	4	21	15
Chengdu Hospital of Sichuan PAP Corps	Southwest	0	0	4	0
General Hospital of Sichuan PAP Corps	Southwest	0	27	57	68
Leshan Hospital of Sichuan PAP Corps	Southwest	0	4	0	0

ACS, acute coronary syndrome; PAP, people's armed police; PCI, percutaneous coronary intervention; PLA, people's liberty army; FMMU, fourth military medical university; SMMU, second military medical university; TMMU, third military medical university.

Table S2. Medical coverage of ACS patients undergoing PCI during 2013-2014

	2013*		2014		
	n	%	n	%	*P*
Medical coverage	18217		39361		
Urban resident MS	9728	53.4	21083	53.6	.72
New rural cooperative MS	3665	20.1	8714	22.1	< .0001
Self-paid	3136	17.2	6401	16.3	< .01
Free MS	572	3.1	915	2.3	< .0001

Commercial insurance	518	2.8	911	2.3	.0001
Others	793	4.4	2043	5.2	< .0001

ACS, acute coronary syndrome; MS, medical service; PCI, percutaneous coronary intervention; * Data were from part of 2013, not from the calendar year due to a systematic revision of the registry form since 2013.

Table S3. Distribution of location of prior MI and Killip classification of ACS patients undergoing PCI during 2011-2013

	2011		2012		2013*		*P* value
	n	%	n	%	n	%	for trend
Prior MI							
Location	5306		5355		3255		
Inferior	2449	46.2	2520	47.1	1458	44.8	.33
Anterior	2189	41.3	2261	42.2	1450	44.5	< .01
Anteroseptal	424	8.0	361	6.7	176	5.4	< .0001
Posterior	114	2.1	99	1.8	85	2.6	.26
Anterolateral	103	1.9	85	1.6	47	1.4	.07
Right ventricular	27	0.5	29	0.5	39	1.2	< .001
Killip classification	5497		5897		4035		
I	2034	37.0	2382	40.4	1499	37.1	.59
II	2405	43.8	2454	41.6	1986	49.2	< .0001
III	768	14.0	792	13.4	437	10.8	< .0001
IV	290	5.3	269	4.6	113	2.8	< .0001

ACS, acute coronary syndrome; MI, myocardial infaction; PCI, percutaneous coronary intervention; * Data were from part of 2013, not from the calendar year due to a systematic revision of the registry form since 2013.

Table S4. Time delay of STEMI patients undergoing primary PCI during 2013-2014

	2013*	2014	
	Median (IQR)	Median (IQR)	*P*
	(n = 1495)	(n = 3484)	
Time delay, mins			
Angina to Balloon	270 (190-415)	270 (190-421)	.65
Angina to FMC	225 (130-350)	220 (121-360)	.53
FMC to Balloon	40 (30-70)	50 (30-75)	< .01

FMC, first medical contact; IQR, interquartile range; MS, medical service; PCI, percutaneous coronary intervention; STEMI, ST elevation myocardial infarction; * Data were from part of 2013, not from the calendar year due to a systematic revision of the registry form since 2013.

Table S5. Assisted device applied perioperatively in ACS patients undergoing PCI during 2011-2013

	2011		2012		2013*		*P* value
	n	%	n	%	n	%	for trend
Assisted device	30800		34974		21307		
Temporary pacemaker	730	2.4	797	2.3	395	1.9	< .001
OCT	19	0.1	43	0.1	30	0.1	< .01

ACS, acute coronary syndrome; OCT, optical coherence tomography; PCI, percutaneous coronary intervention;

[*] Data were from part of 2013, not from the calendar year due to a systematic revision of the registry form since 2013.

Table S6. Thrombolysis of STEMI patients during 2013-2014

	2013[*]		2014		
	n	%	n	%	*P*
Thrombolysis	3564		7856		
Yes	52	1.5	118	1.5	.86
No	3512	98.5	7738	98.5	
Thrombolytic	52		118		
Urokinase	33	63.5	67	56.8	.41
Reteplase	8	15.4	17	14.4	.87
Alteplase	4	7.7	17	14.4	.31
Prourokinase	3	5.8	12	10.2	.56
Others	4	7.7	5	4.2	.46
Time delay, mins[#]					
Angina to thrombolysis	150 (89-223)		190 (130-301)		< .05
Angina to FMC	120 (60-210)		160 (80-270)		.08
FMC to thrombolysis	30 (20-33)		30 (20-40)		.64
Thrombolysis success	52		118		
Yes	44	84.6	73	61.9	< .01
No	8	15.4	45	38.1	

FMC, first medical contact; STEMI, ST elevation myocardial infarction; [*] Data were from part of 2013, not from all of the calendar year due to a systematic revision of the registry form since 2013; [#] data in the subitems were shown as median (interquartile).

Table S7. PCI outcomes of ACS patients during 2013-2014

	2013[*]		2014		
	n	%	n	%	*P*
TIMI flow pre-PCI	21710		46928		
0	4254	19.6	10840	23.1	< .0001
1	2139	9.9	6763	14.4	< .0001
2	2850	13.1	4909	10.5	< .0001
3	12467	57.4	24416	52.0	< .0001
TIMI flow post-PCI	21705		46922		
0	347	1.6	645	1.4	< .05
1	82	0.4	183	0.4	.81
2	283	1.3	374	0.8	< .0001
3	20993	96.7	45720	97.4	< .0001
Guiding wire through lesion	21670		46890		
Yes	21322	98.4	46184	98.5	.32
No	348	1.6	706	1.5	
Stent restenosis[#]	21734		46930		
Yes	354	1.6	857	1.8	.07
No	21380	98.4	46073	98.2	
Residual stenosis of lesion	21660		46892		

< 10%	19912	91.9	45367	96.7	< .0001
10-50%	763	3.5	537	1.1	< .0001
> 50%	985	4.5	988	2.1	< .0001
FFR applied	21756		46938		
Yes	107	0.5	189	0.4	.10
No	21649	99.5	46749	99.6	
Luminal stenosis by IVUS	178		439		
Percentage, %	76 (70-85)		77 (71-83)		.52
Minimal luminal area, mm^2	3.04 (2.68-4.00)		3.25 (2.60-4.00)		.59
Implanted stent per patient**	1.5 ± 0.7		1.4 ± 0.7		< .01

ACS, acute coronary syndrome; IVUS, intravascular ultrasound; FFR, fractional flow reserve; PCI, percutaneous coronary intervention; TIMI, thrombolysis in myocardial infarction; * Data were from part of 2013, not from the calendar year due to a systematic revision of the registry form since 2013; # within lesion categories; ** Mean ± SD, n = 19363, 42299 in 2013-2014, respectively.

Table S8. Stent manufacturer of ACS patients undergoing PCI during 2013-2014

	2013*		2014		
	n	%	n	%	*P*
Stent manufacturer	28181		60847		
Domestic	18345	65.1	37591	61.8	< .0001
MicroPort	6855	24.3	13862	22.8	< .0001
JW Medical	6678	23.7	13214	21.7	< .0001
Lepu Medical	4503	16.0	9868	16.2	.37
Yinyi Biotech	309	1.1	647	1.1	.66
Foreign	6550	23.2	14931	24.5	< .0001
Abbott	3164	11.2	6943	11.4	.42
Medtronic	2464	8.7	5514	9.1	.12
Boston scientific	922	3.3	2474	4.1	< .0001
Others	3286	11.7	8325	13.7	< .0001

ACS, acute coronary syndrome; PCI, percutaneous coronary intervention; * Data were from part of 2013, not from the calendar year due to a systematic revision of the registry form since 2013.

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4,5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	5
		(*b*) Describe any methods used to examine subgroups and interactions	5
		(*c*) Explain how missing data were addressed	5
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6,7,8,9,10,11
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	11,12
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	In Suplementary tables.
		(*b*) Report category boundaries when continuous variables were categorized	11
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	12,13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	17
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	17
Generalisability	21	Discuss the generalisability (external validity) of the study results	17
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	18

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.