

Knowledge, Attitudes, and Practices Regarding Post-Cardiac Arrest Syndrome Among Chinese Physicians: A Dual-Center Cross-Sectional Study

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Background: Post-cardiac arrest syndrome (PCAS) occurs after cardiac arrest resuscitation, causing cardiac and neurological sequelae if not well treated. In China, physicians are vital in PCAS management from early diagnosis, therapeutic treatment to individualized care. Physicians' knowledge, attitudes, and practices (KAP) towards the condition significantly affect such process, which remain understudied in China.

Objective: This study aimed to investigate physicians' KAP regarding PCAS.

Methods: This dual-center cross-sectional study was conducted in June 2024 at Sun Yat-Sen Memorial Hospital, affiliated to Sun Yat-Sen University and Shenshan Medical Center, affiliated to Memorial Hospital of Sun Yat-Sen University. Self-developed questionnaires were used to gather demographic and KAP data, yielding 633 responses.

Results: A total of 551 valid questionnaires were included, with 51.2% of respondents being male. The mean scores for KAP were 8.12 ± 1.66 (range: 0–12), 47.96 ± 5.13 (range: 12–60), and 49.00 ± 5.26 (range: 11–55), respectively. Spearman correlation analysis revealed positive correlations between knowledge and attitudes ($r=0.248$, $P<0.001$), knowledge and practices ($r=0.243$, $P<0.001$), and attitudes and practices ($r=0.369$, $P<0.001$). The structural equation modeling (SEM) results confirmed direct associations between knowledge and attitudes ($\beta=0.500$, 95% CI: 0.401–0.598, $P<0.001$), knowledge and practices ($\beta=0.345$, 95% CI: 0.263–0.428, $P<0.001$), and attitudes and practices ($\beta=0.691$, 95% CI: 0.608–0.773, $P<0.001$).

Conclusion: Physicians exhibited limited knowledge, negative attitudes, and proactive practices regarding PCAS. Future educational and behavioral interventions are necessary to enhance physicians' KAP towards PCAS.

Keywords: post-cardiac arrest syndrome, knowledge, attitude, practice, cross-sectional study

Introduction

Post-cardiac arrest syndrome (PCAS) represents a multifaceted pathophysiological state following successful resuscitation.¹ The condition is characterized by four principal components: (1) post-arrest cerebral injury, (2) myocardial dysfunction, (3) systemic ischemia-reperfusion phenomena, and (4) persistent underlying pathology.¹ The prevalence of PCAS is closely linked to the incidence of cardiac arrest and survival rates following resuscitation. The incidence of out-of-hospital cardiac arrest (OHCA) has been estimated to range from 30.0 to 97.1 per 100,000 population per year.² Besides, the incidence of in-hospital cardiac arrest (IHCA) has reached 5.1 per 1000 hospital admissions, with survival rates to discharge at 12.9%.³ The impact of PCAS on patients who survive the initial insult extends far beyond the acute phase of care. Neurological impairment ranges from mild cognitive deficits to severe disability, profoundly influencing patients' quality of life and functional independence.⁴ Physical functioning is frequently compromised due to both direct



myocardial injury and the systemic effects of prolonged ischemia and reperfusion, leading to persistent fatigue, reduced exercise capacity, and an increased risk of subsequent cardiovascular events.⁵ These multifaceted complications necessitate a coordinated and informed approach by healthcare providers, particularly physicians, who are pivotal in managing these patients.

Physicians play important roles in preventing PCAS initiation and progression, including careful monitoring of vital signs, optimizing hemodynamic status, and preventing secondary brain injury.⁶ For early and accurate diagnosis to guide treatment decisions, physicians rely on advanced imaging, electroencephalography, and biomarkers to assess the extent of brain injury and other systemic complications.⁷ Additionally, the therapeutic management of PCAS by physicians is a cornerstone of patient care, which includes the administration of neuroprotective strategies, the management of electrolyte imbalances, and the prevention of infections.^{8,9} Moreover, physicians must be adept at providing individualized care, considering the patient's overall prognosis and potential for recovery.¹⁰ In the above management steps, the role of physicians in addressing PCAS is vital for patients' clinical outcomes and long-term prognosis.

The knowledge, attitudes, and practices (KAP) studies typically explore the understanding, attitudes, and behaviors of specific health issues using both quantitative and qualitative methods.¹¹ This methodology can be used to assess what physicians know about PCAS, their attitudes towards its management, and the practices they implement in clinical settings, which provides a comprehensive understanding of how care is delivered. To our knowledge, limited KAP evidence exists regarding physician management of PCAS. For instance, a web-based survey found 93.95% of physicians reported targeted temperature management (TTM) use as standard practice, yet 56.46% maintained unchanged protocols despite updated trial evidence.¹² A French nationwide survey revealed only 2.2% of physicians counseled patients on driving restrictions for post-arrest cognitive impairments, while half documented neurological outcomes at ICU discharge using standardized scales.¹³ Moreover, a US study identified strong emergency team communication and acute stabilization skills but persistent system-level challenges, including staffing shortages, bed capacity limitations, and transfer delays.¹⁴ As these findings derive exclusively from Western healthcare systems—which differ substantially from China's infrastructure and training paradigms—a critical evidence gap remains regarding PCAS management in Chinese clinical practice.

The aim of this study was to bridge this gap by exploring the KAP of physicians towards PCAS and determining the influential factors. Our findings can provide insights into the factors that drive clinical decision-making in the management of PCAS and identify areas where targeted interventions may enhance patient outcomes.

Methods

Study Design and Participants

This dual-center cross-sectional study was conducted in June 2024 at Sun Yat-Sen Memorial Hospital, affiliated to Sun Yat-Sen University and Shenshan Medical Center, affiliated to Memorial Hospital of Sun Yat-Sen University. The inclusion criteria were: (1) physicians from the Internal Medicine, ICU, Emergency, and Cardiac Surgery departments; (2) physicians with valid medical practitioner qualification certificates; and (3) physicians currently engaged in clinical work. The exclusion criteria were physicians who refused to participate.

Ethical approval was obtained from the Medical Ethics Committee of Sun Yat-sen Memorial Hospital, affiliated to Sun Yat-sen University (Approval number: SYSKY-2024-481-01). Informed consent was secured from all participants.

Questionnaire Design

The draft of the questionnaire was developed based on the *Chinese Emergency Expert Consensus on the Diagnosis and Treatment of Post-Cardiac Arrest Syndrome in Adults 2021*.¹⁰ A pilot study was carried out for reliability testing, and 47 valid questionnaires were collected. The Cronbach's α coefficient of 0.841 indicated good internal consistency.

The final questionnaire, in Chinese, included four sections: demographic data, knowledge, attitude, and practice dimensions ([Supplementary Material 1](#)). Basic information included gender, age, education, the type of the institution, teaching hospital status, professional title, department, years of clinical experience, average monthly PCAS patient cases, and participation in PCAS-related training. The knowledge dimension comprised 12 items, with each correct response

earning 1 point, and incorrect or uncertain responses earning 0 points. The total score of the knowledge dimension ranged from 0 to 12 points. The attitude dimension contained 12 questions using a five-point Likert scale. Positive items were scored from strongly agree (5 points) to strongly disagree (1 point), while negative items (items 3, 8–11) were reversely scored. The total score of the attitude dimension ranged from 12 to 60 points. The practice dimension included 12 questions, with item 8 analyzed descriptively and not scored. The remaining 11 items were scored from strongly agree (5 points) to strongly disagree (1 point). The total score of the practice dimension ranged from 11 to 55 points. The KAP scores were categorized based on Bloom's cut-off values, with scores >80% representing adequate knowledge, positive attitudes, and proactive practices, and scores 80% denoting limited knowledge, negative attitudes, and inactive practices.¹⁵

Questionnaire Distribution

A convenience sampling approach was adopted in the two tertiary hospitals. The study enrolled physicians from PCAS-related departments, including internal medicine, cardiac surgery, ICU, emergency medicine, and other relevant clinical specialties. The survey was primarily administered through one-on-one delivery via WeChat, either directly by the researchers or through colleagues who facilitated distribution within their departments. Prior to participation, all physicians were informed about the study's objectives and provided electronic informed consent. During the survey, the research team addressed any participant inquiries through WeChat communication. Participant anonymity was ensured throughout the entire data collection process. Upon completion, the research team meticulously reviewed the questionnaires for completeness. Responses with a completion time of less than 60 seconds, those containing logical inconsistencies, or exhibiting uniform answers were deemed invalid and excluded from the final analysis.

Sample Size Calculation

The calculation of sample size was based on the following formula:¹⁶

$$n = \left(\frac{Z_{1-\frac{\alpha}{2}}}{\delta} \right)^2 \times p \times (1 - p)$$

$$n = (Z_{\alpha/2})^2 \times p(1 - p) / d^2$$

where n denotes the sample size. Besides, P value was assumed to be 0.5 to achieve the maximum sample size. α refers to the type I error, which was set to 0.05 in this case. Subsequently, $Z_{1-\frac{\alpha}{2}}$ was yielded 1.96. δ represents the effect sizes between groups, which was determined as 0.05, and at least 384 participants should be required. Considering a 20% non-response rate, a total of 480 participants were required.

Statistical Methods

Statistical analysis was conducted using R 4.3.2 and Stata 18.0 (StataCorp LLC, College Station, TX, USA). Categorical data were expressed as numbers (%), and continuous variables as mean \pm standard deviation (SD). For normally distributed continuous variables, t -tests or ANOVA were employed. For continuous variables with skewed distribution, Mann–Whitney tests or Kruskal–Wallis analysis were used. Spearman correlation analysis was performed to assess the relationships between KAP dimension scores. Univariate and multivariate logistic regression analyses were conducted to identify influencing factors, using an 80% threshold for each KAP dimension. Variables with $P < 0.1$ in univariate analysis were included in multivariate regression. Structural equation modeling (SEM) was used to test hypotheses that: (1) physicians' knowledge has a positive effect on their attitudes towards PCAS; (2) physicians' knowledge positively impacts their clinical practices in managing PCAS; and (3) physicians' attitudes significantly influence their practices. Model fit was evaluated using the root mean square error of approximation (RMSEA), standardized root mean square residual (SRMR), Tucker–Lewis index (TLI), and comparative fit index (CFI). A two-sided $P < 0.05$ was considered statistically significant.

Results

Initially, 633 responses were included. After excluding 14 participants without informed consent, 5 with response times under 60 seconds, 2 with outlier ages, and 61 with logical inconsistencies, 551 valid responses remained. The Cronbach's α for the overall scale was 0.8200, with subscale reliabilities of 0.7036 for knowledge, 0.7846 for attitudes, and 0.8641 for practices. The overall KMO value was 0.8803. Among the participants, 51.2% were male, and 51.9% were aged 29–35 years. A total of 41.4% held an intermediate professional title, and 33.8% were employed in the Department of Cardiac Surgery. Most participants worked in tertiary institutions (85.7%) and teaching hospitals (76.2%). Nearly half (46.1%) had not participated in PCAS-related training (Table 1).

The mean score for knowledge was 8.12 ± 1.66 (range: 0–12). Significant differences in knowledge scores were observed across age groups ($P < 0.001$), institution types ($P = 0.009$), professional titles ($P < 0.001$), departments ($P < 0.001$), years of clinical practice ($P < 0.001$), and average monthly PCAS cases ($P < 0.001$) (Table 1). Accuracy rates in the knowledge dimension varied from 36.1% to 97.8%. The highest accuracy (97.8%) was in identifying systemic ischemia-reperfusion injury as the pathological damage process of PCAS (K2c). The lowest accuracy (36.1%) was for the recommendation to routinely administer rapid intravenous ice-cold saline to induce cooling in ROSC patients before hospital admission (K11). Additionally, only 51.0% correctly recognized that coronary angiography should be performed when an electrocardiogram indicates ST-segment depression (K4b) (Table 2).

Participants achieved the mean score of 47.96 ± 5.13 (range: 12–60) in the attitude dimension. Attitude scores varied significantly by age group ($P = 0.001$), education level ($P < 0.001$), institution types ($P < 0.001$), teaching hospital affiliation ($P = 0.013$), professional title ($P = 0.010$), department ($P = 0.001$), and average monthly PCAS cases ($P = 0.014$) (Table 1). Positivity rates in the attitudes dimension ranged from 17.2% to 97.3%. The majority (97.3%) showed high confidence in the necessity of early bundled care management for improving outcomes in PCAS patients (A2). The lowest positivity rate (17.2%) was for disagreement with the statement that all ROSC patients must undergo hypothermia treatment to protect neurological function (A10). Additionally, only 40.7% disagreed that neurological prognosis in PCAS patients should be evaluated exclusively by neurologists (A8) (Table 3).

The physicians had mean practice scores of 49.00 ± 5.26 (range: 11–55). Practice scores differed significantly by age group ($P = 0.010$), institution types ($P = 0.002$), department ($P = 0.029$), average monthly PCAS cases ($P = 0.015$), and participation in PCAS-related training ($P < 0.001$) (Table 1). The comparison analysis of scores in individual item showed that physicians with prior experience in PCAS-related resuscitation outperformed those without such experience in p1, p7, p11, p12 and mean score (all $P < 0.05$) (Table S1). Besides, physicians involved in PCAS-related training had significantly elevated mean scores and certain item performance (p1, 4, 5, 6, 7, 9, 11 and 12) (all $P < 0.05$) (Table S2). Practice adherence rates varied from 74.4% to 95.4%. The highest adherence (95.4%) was in actively assessing the extent of central nervous system damage and implementing combined protective measures during post-cardiopulmonary resuscitation care to mitigate neurological damage (P6). The lowest adherence rate (74.4%) was for promptly initiating hypothermia treatment for comatose PCAS patients (P7). Regarding techniques for hypothermia management, 97.6% of participants used surface cooling devices (eg, ice blankets, ice caps), followed by intravascular cooling devices (eg, DuoFlo targeted hypothermic brain protection technology) (73.9%), and intravenous ice-cold saline administration in the hospital (57.4%) (Table 4).

Spearman correlation analysis revealed positive correlations between knowledge and attitude ($r = 0.248$, $P < 0.001$), knowledge and practice ($r = 0.243$, $P < 0.001$), and attitude and practice ($r = 0.369$, $P < 0.001$) (Table S3). Multivariate analysis showed that holding a doctorate degree (OR=2.417, 95% CI: 1.056–5.536, $P = 0.037$) and working in the Emergency Department, Cardiac Surgery, and other departments (OR=0.279–0.562, all $P < 0.05$) were independently associated with knowledge (Table S4). Knowledge (OR=1.153, 95% CI: 1.025–1.296, $P = 0.017$), being over 35 years old (OR=3.572, 95% CI: 1.397–9.135, $P = 0.008$), working outside a tertiary institution (OR=0.382, 95% CI: 0.197–0.741, $P = 0.004$), working in other departments (OR=0.392, 95% CI: 0.219–0.703, $P = 0.002$), and having 11–15 years of clinical practice (OR=0.267, 95% CI: 0.106–0.672, $P = 0.005$) were independently associated with attitude (Table S5). Knowledge (OR=1.230, 95% CI: 1.082–1.397, $P = 0.002$), attitude (OR=1.128, 95% CI: 1.083–1.174, $P < 0.001$) and lack of

Table 1 Basic Information of Participants and KAP Score

Variables	N (%)	Knowledge (mean ± SD)	P	Attitudes (mean ± SD)	P	Practices (mean ± SD)	P
Total Score	552 (100.0)	8.12 ± 1.66		47.96 ± 5.13		49.00 ± 5.26	
Gender			0.440		0.330		0.809
Male	282 (51.2)	8.16 ± 1.72		47.73 ± 5.29		49.10 ± 5.11	
Female	269 (48.8)	8.08 ± 1.61		48.20 ± 4.95		48.90 ± 5.42	
Age			<0.001		0.001		0.010
28 years and below	102 (18.5)	7.74 ± 1.65		46.68 ± 5.43		47.39 ± 5.90	
29-35 years	286 (51.9)	8.06 ± 1.66		47.72 ± 5.16		49.26 ± 4.95	
Above 35 years	163 (29.6)	8.47 ± 1.62		49.19 ± 4.61		49.56 ± 5.20	
Education			0.509		<0.001		0.109
Bachelor's degree or below	265 (48.1)	8.03 ± 1.69		47.02 ± 5.13		48.56 ± 5.46	
Master's degree	228 (41.4)	8.20 ± 1.59		48.53 ± 5.02		49.28 ± 5.04	
Doctorate	58 (10.5)	8.19 ± 1.81		50.00 ± 4.66		49.95 ± 5.11	
Type of Hospital			0.009		<0.001		0.002
Public tertiary hospital	472 (85.7)	8.18 ± 1.65		48.33 ± 5.06		49.27 ± 5.18	
Other*	79 (14.3)	7.73 ± 1.68		45.72 ± 4.96		47.43 ± 5.48	
Teaching Hospital			0.576		0.013		0.300
Yes	420 (76.2)	8.13 ± 1.69		48.29 ± 5.04		49.14 ± 5.17	
No	131 (23.8)	8.08 ± 1.58		46.92 ± 5.29		48.58 ± 5.53	
Professional Title			<0.001		0.010		0.154
None	31 (5.6)	8.19 ± 1.14		47.58 ± 5.40		48.77 ± 5.20	
Junior	211 (38.3)	7.81 ± 1.73		47.27 ± 5.30		48.55 ± 5.48	
Intermediate	228 (41.4)	8.21 ± 1.67		48.06 ± 4.99		49.05 ± 5.13	
Associate Senior/Senior	81 (14.7)	8.67 ± 1.51		49.64 ± 4.61		50.12(5.01)	
Department			<0.001		0.001		0.029
Internal Medicine	184 (33.4)	8.59 ± 1.64		48.88 ± 5.07		49.84 ± 4.94	
ICU	48 (8.7)	8.50 ± 1.46		48.98 ± 5.31		49.27 ± 5.84	
Emergency Department	31 (5.6)	7.74 ± 1.55		48.48 ± 4.00		49.68 ± 5.05	
Cardiac Surgery	186 (33.8)	7.84 ± 1.60		47.44 ± 4.98		48.44 ± 5.23	
Other	102 (18.5)	7.72 ± 1.73		46.61 ± 5.37		48.21 ± 5.50	
Years of Clinical Practice			<0.001		0.120		0.343
≤5 years	214 (38.8)	7.82 ± 1.54		47.47 ± 5.15		48.62 ± 5.45	
5-10 years	190 (34.5)	8.13 ± 1.77		48.07 ± 5.37		49.13 ± 4.86	
11-15 years	69 (12.5)	8.41 ± 2.01		48.04 ± 4.49		48.72 ± 5.98	
≥16 years	78 (14.2)	8.65 ± 1.19		48.97 ± 4.91		50.00 ± 4.96	
Average Monthly PCAS Patient Cases In The Past Year			<0.001		0.014		0.015
None	272 (49.4)	7.77 ± 1.78		47.32 ± 5.23		48.29 ± 5.65	
1-3 cases	237 (43.0)	8.46 ± 1.47		48.63 ± 4.93		49.64 ± 4.72	
≥4 cases	42 (7.6)	8.50 ± 1.49		48.33 ± 5.12		50.05 ± 5.03	
Participation in PCAS-related Training			0.116		0.097		<0.001
Yes	297 (53.9)	8.28 ± 1.50		48.26 ± 5.26		49.73 ± 5.08	
No	254 (46.1)	7.93 ± 1.82		47.61 ± 4.95		48.15 ± 5.35	

Note: *Other hospitals include secondary-level public hospitals, primary-level public hospitals, and private hospitals.

Abbreviation: ICU, intensive care unit.

participation in PCAS-related training (OR=0.648, 95% CI: 0.446–0.942, P=0.023) were negatively associated with practice (Table S6).

Table 2 Knowledge Dimension of the Participants

Knowledge	Correct	Incorrect	Unsure
1. During cardiac arrest (CA), the body experiences severe ischemia and hypoxia of various organs and tissues, leading to the release of inflammatory factors and the production of various metabolic byproducts. Following the return of spontaneous circulation (ROSC), reperfusion injury occurs, resulting in multiple organ dysfunction or impairment, which is known as postcardiac arrest syndrome (PCAS).	538(97.6%)	5(0.9%)	8(1.5%)
2a. The pathological damage process of PCAS includes (multiple choices allowed): (a. Brain injury following CA)	532(96.6%)	19(3.4%)	
2b. Myocardial dysfunction post-CA)	534(96.9%)	17(3.1%)	
2c. Systemic ischemia-reperfusion injury)	539(97.8%)	12(2.2%)	
2d. Persistent pathogenic causes and triggers (such as acute coronary syndrome, pulmonary embolism, sepsis, etc.))	514(93.3%)	37(6.7%)	
3. The key to treating PCAS lies in reversing pathophysiological manifestations through timely and appropriate post-CA bundled care management.	513(93.1%)	12(2.2%)	26(4.7%)
4a. Coronary angiography should be performed under the following conditions (multiple choices allowed): (a. Suspected cardiogenic cause of out-of-hospital CA)	532(96.6%)	19(3.4%)	
4b. Electrocardiogram indicating ST-segment depression)	281(51.0%)	270(49%)	
4c. Electrocardiogram indicating ST-segment elevation)	502(91.1%)	49(8.9%)	
4d. Absence of contraindications)	352(63.9%)	199(36.1%)	
5. During post-cardiopulmonary resuscitation care, hypotension should be avoided and corrected immediately, with a target mean arterial pressure above 80 mmHg.	374(67.9%)	138(25%)	39(7.1%)
6. Norepinephrine is recommended as the first-line vasopressor for post-CA patients.	420(76.2%)	70(12.7%)	61(11.1%)
7. For PCAS patients who remain in shock despite pharmacological treatment, extracorporeal mechanical circulatory support (such as extracorporeal membrane oxygenation) should be considered.	523(94.9%)	6(1.1%)	22(4%)
8. During post-cardiopulmonary resuscitation care, PaCO ₂ should be maintained within the normal physiological range, and SaO ₂ should not fall below 94%.	408(74%)	89(16.2%)	54(9.8%)
9a. To mitigate secondary neurological damage in PCAS patients, the following protective measures can be adopted (multiple choices allowed): (a. Neurological examination)	507(92%)	44(8%)	
9b. Maintaining body temperature at 37°C)	353(64.1%)	198(35.9%)	
9c. Head CT screening for cerebral edema)	522(94.7%)	29(5.3%)	
9d. Use of neuromuscular blocking agents if necessary)	372(67.5%)	179(32.5%)	
10. For the management of comatose PCAS patients, target temperature management can be selected and maintained at a constant temperature between 32–36°C for at least 24 hours after achieving the target temperature.	482(87.5%)	16(2.9%)	53(9.6%)
11. It is recommended to routinely administer rapid intravenous ice-cold saline to induce cooling in ROSC patients before hospital admission.	199(36.1%)	240(43.6%)	112(20.3%)
12. Continuous electroencephalographic monitoring should be considered if there is concern about clinical or subclinical seizures in PCAS patients.	494(89.7%)	23(4.2%)	34(6.2%)

Goodness-of-fit indices indicated a modest model fit for the SEM (RMSEA=0.052, SRMR=0.061, TLI=0.837, CFI=0.849) (Table S7). The SEM results confirmed direct associations between knowledge and attitude ($\beta=0.500$, 95% CI: 0.401–0.598, $P<0.001$), knowledge and practice ($\beta=0.345$, 95% CI: 0.263–0.428, $P<0.001$), and attitude and practice ($\beta=0.691$, 95% CI: 0.608–0.773, $P<0.001$). Additionally, knowledge was indirectly associated with practice ($\beta=0.504$, 95% CI: 0.416–0.591, $P<0.001$) (Figure 1 and Table 5).

Discussion

The study revealed that physicians had limited knowledge, negative attitudes, and proactive practices towards PCAS. The positive interrelationships were identified among KAP scores, and their influential factors were determined. Moreover, an indirect association between knowledge and practice was observed, suggestive of mediating role of attitude. The findings

Table 3 Attitude Dimension of the Participants

Attitude	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. I believe that PCAS is closely related to the prognosis of CA patients and needs to be taken seriously.	479(86.9%)	55(10%)	16(2.9%)	1(0.2%)	0 (0%)
2. I believe that early bundled care management is necessary for PCAS patients to improve outcomes.	481(87.3%)	55(10%)	14(2.5%)	1(0.2%)	0 (0%)
3. I believe that the bundled care management process for PCAS is complex, consuming medical staff's time and leading to a waste of medical resources.	93(16.9%)	35(6.4%)	116(21.1%)	130(23.6%)	177(32.1%)
4. I believe that coronary angiography can be performed on PCAS patients with indications for the procedure, whether they are comatose or conscious.	238(43.2%)	174(31.6%)	88(16%)	38(6.9%)	13(2.4%)
5. I believe it is necessary to optimize the hemodynamic and gas exchange management of PCAS patients.	396(71.9%)	120(21.8%)	35(6.4%)	0 (0%)	0 (0%)
6. I believe that mechanical circulatory support technologies (such as extracorporeal membrane oxygenation) can provide hemodynamic support for PCAS patients in shock.	380(69%)	124(22.5%)	45(8.2%)	2(0.4%)	0 (0%)
7. I believe that both hypoxemia and hyperoxia after CA are harmful.	319(57.9%)	135(24.5%)	54(9.8%)	35(6.4%)	8(1.5%)
8. I believe that the neurological prognosis of PCAS patients should be entirely evaluated by neurologists.	95(17.2%)	97(17.6%)	135(24.5%)	153(27.8%)	71(12.9%)
9. I believe that hypothermia is primarily for research purposes and has limited clinical application.	28(5.1%)	35(6.4%)	91(16.5%)	225(40.8%)	172(31.2%)
10. I believe that all ROSC patients must undergo hypothermia treatment to protect neurological function.	132(24%)	175(31.8%)	149(27%)	73(13.2%)	22(4%)
11. I believe that post-ROSC interventions should primarily focus on medication, with nursing playing a minor role in merely executing doctors' orders.	42(7.6%)	31(5.6%)	42(7.6%)	137(24.9%)	299(54.3%)
12. I am confident in my ability to manage PCAS patients effectively.	131(23.8%)	198(35.9%)	185(33.6%)	27(4.9%)	10(1.8%)

Table 4 Practice Dimension of the Participants

Practice	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. Do your practices for managing PCAS align with the following description? I will promptly and comprehensively monitor PCAS patients and perform bundled care management guided by monitored vital signs.	313(56.8%)	174(31.6%)	58(10.5%)	5(0.9%)	1(0.2%)
2. If an out-of-hospital CA patient is suspected to have a cardiogenic cause, the ECG shows ST-segment elevation, and contraindications are excluded, I will perform an emergency coronary angiography.	359(65.2%)	154(27.9%)	35(6.4%)	2(0.4%)	1(0.2%)
3. I will adjust the blood pressure of PCAS patients based on their specific condition to achieve optimal perfusion.	339(61.5%)	179(32.5%)	28(5.1%)	4(0.7%)	1(0.2%)
4. For PCAS patients who remain in shock despite pharmacological treatment, I will choose mechanical circulatory support technology based on the patient's hemodynamic status, the expected hemodynamic impact of the device, the ease and speed of device installation, potential complications and contraindications, and the ultimate support goals.	319(57.9%)	195(35.4%)	33(6%)	4(0.7%)	0 (0%)

(Continued)

Table 4 (Continued).

Practice	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5. If FiO ₂ can be measured and blood oxygen saturation monitored, I will reduce FiO ₂ when a PCAS patient's blood oxygen saturation reaches 100%, maintaining it above 94%.	292(53%)	202(36.7%)	40(7.3%)	16(2.9%)	1(0.2%)
6. During post-cardiopulmonary resuscitation care, I will actively assess the extent of central nervous system damage and implement combined protective measures to mitigate neurological damage (eg, neurological examination, target temperature management, head CT screening for cerebral edema, etc.).	344(62.4%)	182(33%)	23(4.2%)	2(0.4%)	0 (0%)
7. I will promptly initiate hypothermia treatment for comatose PCAS patients.	209(37.9%)	201(36.5%)	111(20.1%)	28(5.1%)	2(0.4%)
8a. I will use the following techniques for hypothermia management in PCAS patients (multiple choices allowed): (a. Surface cooling devices (eg, ice blankets, ice caps))	538(97.6%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
8b. Intravascular cooling devices (eg, DuoFlo targeted hypothermic brain protection technology))	407(73.9%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
8c. Intravenous ice-cold saline administration in the hospital)	316(57.4%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
9. I will carefully choose the timing of rewarming based on the extent of neurological damage in PCAS patients.	262(47.5%)	223(40.5%)	59(10.7%)	6(1.1%)	1(0.2%)
10. When assessing the neurological prognosis of PCAS patients, I will consult neurologists.	326(59.2%)	192(34.8%)	25(4.5%)	8(1.5%)	0 (0%)
11. I will discuss the prognosis and treatment goals of PCAS patients with their families.	348(63.2%)	169(30.7%)	28(5.1%)	6(1.1%)	0 (0%)
12. I will actively learn about PCAS management.	318(57.7%)	197(35.8%)	23(4.2%)	13(2.4%)	0 (0%)

can provide insights into the factors that drive clinical decision-making in the management of PCAS and identify areas where targeted interventions may enhance patient outcomes.

The limited knowledge observed among physicians could be attributed to several factors, including insufficient exposure to PCAS-specific education during medical training or a lack of continuous professional development focused on this area. A French survey echoed our results, where only half of ICUs offered follow-up consultations for cardiac arrest survivors, with cognitive and emotional outcomes frequently excluded from discharge discussions.¹³ Similarly, a narrative review highlighted suboptimal awareness and adoption of lung-protective strategies among critical care providers, despite the high incidence of post-arrest lung injury.¹⁷ In addition, the negative attitudes of PCAS were observed among physicians. The findings suggest that knowledge gaps may influence physicians' confidence and self-perception. In line with our results, nurses in Namibia had negative attitudes towards cardiopulmonary resuscitation.¹⁸ Despite the deficits in knowledge and attitude, the proactive practices observed suggest that physicians may rely heavily on clinical guidelines and protocols to manage PCAS, rather than on a deep understanding of the underlying pathophysiology.¹⁴ Therefore, educational interventions on PCAS should be integrated into both undergraduate medical education and continuing professional development programs. Taken together, structured training and continuing education programs are required to enhance physicians' competency and perception, leading the better PCAS management.

The least number of participants routinely administered rapid intravenous ice-cold saline to induce cooling in ROSC patients before hospital admission. This finding is particularly concerning given the critical role that TTM plays in improving neurological outcomes for patients who have achieved ROSC. The science advisory from the American Heart Association emphasizes the importance of TTM, recommending that all comatose adult patients with ROSC after out-of-hospital cardiac arrest should receive TTM as part of their care.¹⁹ Continuous medical education should emphasize the

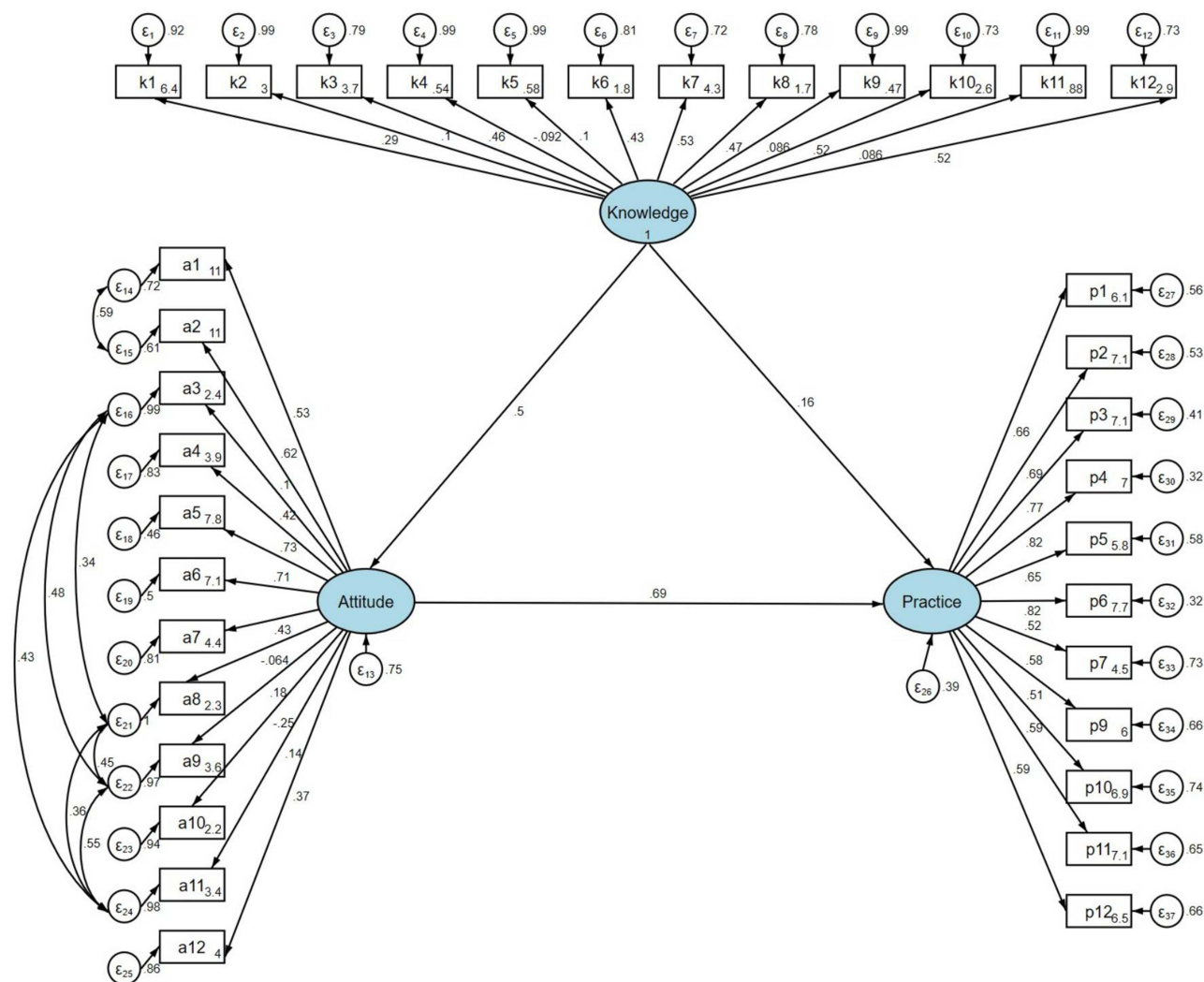


Figure 1 Structural equation model showing the relationship between KAP scores. All variables are observed variables. Direction of causality is indicated by single-headed arrows. The standardized path coefficients are presented alongside the arrows.

importance of initiating cooling measures promptly, even before hospital arrival. Similarly, about half of the physicians correctly recognized that coronary angiography should be performed when an ECG indicates ST-segment depression. Coronary angiography is a key diagnostic tool in the assessment of myocardial ischemia, and its timely use is essential for appropriate intervention. Previous studies have underscored the importance of coronary angiography in patients with suspected myocardial infarction, including those presenting with non-ST elevation.^{20,21} The suboptimal recognition of this indication may lead to delays in treatment, potentially compromising patient outcomes. Educational interventions should be developed, ensuring that physicians are up-to-date with current evidence-based practices of coronary

Table 5 Direct and Indirect Effects of KAP Scores from Structural Equation Model

Model Paths	Total Effects		Direct Effect		Indirect Effect	
	B (95% CI)	P	B (95% CI)	P	B (95% CI)	P
Knowledge → Attitude	0.500 (0.401, 0.598)	<0.001	0.500 (0.401, 0.598)	<0.001		
Attitude → Practice	0.691 (0.608, 0.773)	<0.001	0.691 (0.608, 0.773)	<0.001		
Knowledge → Practice	0.158 (0.056, 0.261)	0.003	0.345 (0.263, 0.428)	<0.001	0.504 (0.416, 0.591)	<0.001

angiography in post-ROSC patients. Additionally, regular guideline updates and case-based training can further enhance physicians' knowledge and improve patient outcomes in post-cardiac arrest care.

In the attitude dimension, the majority either agreed with the universal application of hypothermia treatment or were uncertain about its selective use, which may reflect a lack of consensus or clarity in the interpretation of guidelines. Despite being a well-established intervention, TTM should be applied selectively based on specific clinical criteria. The 2015 AHA guidelines recommend TTM for comatose patients after out-of-hospital cardiac arrest with initial pulseless ventricular tachycardia or ventricular fibrillation, as well as for those after in-hospital cardiac arrest with non-shockable rhythms.²² Regular learning workshops can help improve the dissemination and comprehension of current guidelines regarding therapeutic hypothermia, ensuring that physicians are better informed about when to apply the treatment selectively. Additionally, fewer than half of the physicians disagreed with the statement that neurological prognosis in PCAS patients should be evaluated exclusively by neurologists, suggesting potential gaps in multidisciplinary collaboration. While neurologists play a critical role in assessing neurological outcomes, a multidisciplinary team—including intensivists, cardiologists, and rehabilitation specialists—is essential for comprehensive patient care. Previous studies also have highlighted the importance of collaborative decision-making in the management of post-cardiac arrest patients.^{23,24} Guidelines should encourage regular communications among neurologists and non-neurological physicians to promote shared decision-making, especially in complex cases involving PCAS patients.

In the practice dimension, the lowest adherence rate was for the prompt initiation of hypothermia treatment in comatose PCAS patients. This finding is concerning given the robust evidence supporting therapeutic hypothermia as a critical intervention for improving neurological outcomes in comatose patients following cardiac arrest.²⁵ Furthermore, the lower adherence rate in our study may also reflect challenges in rapidly identifying eligible patients and delays in the initiation of cooling, possibly due to related complications of hypothermia, such as coagulopathy or infection.²⁶ Regarding techniques for hypothermia management, most participants chose surface cooling devices. However, surface cooling alone may result in slower achievement of target temperatures and less precise temperature control compared to other methods.²⁷ Intravascular cooling devices, used by a majority participants, offer more precise temperature control and quicker cooling rates.²⁸ For instance, the DuoFlo targeted hypothermic brain protection technology is designed to rapidly induce and maintain hypothermia with minimal fluctuations in core temperature.²⁹ Besides, intravenous administration of ice-cold saline was reported by more than half of the participants. While this method is effective in reducing core temperature, it may not be as precise or sustained as intravascular methods, and there is a risk of inducing pulmonary edema.³⁰ Continuous updates to clinical guidelines of hypothermia treatment are essential to ensure that physicians are equipped with the latest evidence-based practices.

Positive correlations were observed among KAP scores, suggesting that enhancing physicians' knowledge about PCAS may positively influence both their attitudes and practices. The findings were in accordance with the health belief model, which posits that knowledge can influence health-related attitudes and perceptions of susceptibility, severity, benefits, and barriers.³¹ Several influential factors were further determined. First, advanced academic training may provide physicians with a deeper understanding of PCAS, possibly due to increased exposure to research, critical analysis, and evidence-based medicine during their doctoral studies.³² Second, physicians working in the Emergency Department, Cardiac Surgery, and other departments exhibited significantly lower knowledge levels regarding PCAS. For instance, the Emergency Department often focuses on rapid stabilization and immediate life-saving interventions, which may limit the depth of knowledge concerning post-resuscitation care, including the management of PCAS.³³ Similarly, cardiac surgeons may focus more on the surgical aspects of cardiac care, potentially at the expense of staying current with post-cardiac arrest management guidelines. Third, being older than 35 years were positively associated with attitude. Older physicians, having witnessed the evolution of treatment protocols and patient outcomes over time, may be more attuned to the importance of evidence-based practices.³⁴ Fourth, working outside a tertiary institution was negatively associated with attitude. Tertiary institutions typically have greater access to the latest medical technologies, specialized training, and updated clinical guidelines. The findings underscored that all healthcare providers, regardless of their work setting, have access to ongoing education and training opportunities. Fifth, the observed negative association between PCAS training non-participation and practices underscored continuous education's critical role in enhancing clinical performance. Existing evidence confirms the efficacy of simulation-based and

team-based learning in improving post-resuscitation guideline adherence.^{35,36} These findings support implementing standardized PCAS training modules, simulation workshops, and national continuing education programs to promote evidence-based care and optimize patient outcomes. Moreover, the indirect association between knowledge and practice (path coefficient = 0.504) through attitude suggests the mediating role of attitude. Educational interventions should, therefore, not only aim to increase knowledge but also target attitude shifts to maximize their impact on clinical practices.

The study strengths should be acknowledged. First, the dual-center design, involving both a comprehensive tertiary hospital and a regional medical center, enhanced the generalizability of the findings across different healthcare settings in China. Second, the inclusion of physicians from a wide range of clinical departments ensured the representation of diverse perspectives and practices in the PCAS management. Third, application of a validated KAP framework enabled reliable competency assessment and cross-study comparisons. However, the limitations also existed. First, social desirability bias may have led participants to provide socially acceptable responses rather than reflecting their true behaviors, potentially inflating scores.³⁷ Despite efforts to mitigate this by ensuring anonymity and encouraging honesty, this bias remains a concern. Second, the cross-sectional design restricted the ability to establish causality or temporal relationships. Future research employing longitudinal designs would be valuable in validating these findings and exploring the causal pathways between KAP. Third, the assessment of practices through self-reported responses may not fully capture actual behaviors or competence in real-world scenarios. Future studies incorporating observational or simulation-based assessments are warranted to validate reported practices. Fourth, the SEM yielded TLI and CFI values below thresholds. Nevertheless, SEM empowered simultaneous evaluation of KAP interrelationships, which justified its application in this exploratory investigation of physicians' PCAS-related KAP. Fifth, the findings may not be generalizable to all healthcare institutions in China despite the acceptable sample size. Multicenter studies with broader geographical coverage are warranted to enhance external validity.

Conclusions

In conclusion, physicians had limited knowledge, negative attitudes and proactive practices towards PCAS. Future interventions should emphasize educational programs to enhance their KAP towards PCAS, particularly on TTM, coronary angiography, and multidisciplinary collaboration.

Abbreviations

KAP, knowledge, attitudes, and practices; PCAS, post-cardiac arrest syndrome; ROSC, return of spontaneous circulation; OHCA, out-of-hospital cardiac arrest; IHCA, in-hospital cardiac arrest; SD, standard deviation.

Data Sharing Statement

All data generated or analysed during this study are included in this published article.

Ethics Approval and Consent to Participate

This work has been carried out in accordance with the Declaration of Helsinki (2013) of the World Medical Association. This work was approved by the Medical Ethics Committee of Sun Yat-sen Memorial Hospital, affiliated to Sun Yat-sen University (Approval number: SYSKY-2024-481-01). Informed consent was secured from all participants.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare that they have no competing interests in this work.

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