Original Article

Extensive Variability in Vasoactive Agent Therapy: A Nationwide Survey in Chinese Intensive Care Units

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Abstract

Background: Inconsistencies in the use of the vasoactive agent therapy to treat shock are found in previous studies. A descriptive study was proposed to investigate current use of vasoactive agents for patients with shock in Chinese intensive care settings.

Methods: A nationwide survey of physicians was conducted from August 17 to December 30, 2012. Physicians were asked to complete a questionnaire which focused on the selection of vasoactive agents, management in the use of vasopressor/inotropic therapy, monitoring protocols when using these agents, and demographic characteristics.

Results: The response rate was 65.1% with physicians returning 586 valid questionnaires. Norepinephrine was the first choice of a vasopressor used to treat septic shock by 70.8% of respondents; 73.4% of respondents favored dopamine for hypovolemic shock; and 68.3% of respondents preferred dopamine for cardiogenic shock. Dobutamine was selected by 84.1%, 64.5%, and 60.6% of respondents for septic, hypovolemic, and cardiogenic shock, respectively. Vasodilator agents were prescribed by physicians in the management of cardiogenic shock (67.1%) rather than for septic (32.3%) and hypovolemic shock (6.5%). A significant number of physicians working in teaching hospitals were using vasoactive agents in an appropriate manner when compared to physicians in nonteaching hospitals.

Conclusions: Vasoactive agent use for treatment of shock is inconsistent according to self-report by Chinese intensive care physicians; however, the variation in use depends upon the form of shock being treated and the type of hospital; thus, corresponding educational programs about vasoactive agent use for shock management should be considered.

Key words: Shock; Survey; Variability; Vasoactive Agent Therapy

Introduction

Therapy with vasoactive agents, including vasopressors, inotropes, and vasodilators, is prescribed to correct abnormal vascular tone, and/or to improve cardiac output (CO) in order to restore tissue perfusion and normalize oxygen consumption.[1] Currently, this therapy is considered basic management practice in the care of patients with shock in intensive care units (ICUs). However, previous surveys have suggested that inconsistencies in the use of vasoactive agents existed among ICU physicians, even in Europe or North America.[2-5] One reason for this inconsistency is that the optimal selection and titration of vasoactive agents to treat shock, especially vasopressors, remains debatable.[6,7] In addition, compliance with the Surviving Sepsis Campaign's (SSC's) resuscitation and management bundles including use of vasopressors, reported by a prospective cohort study, is poor, and differences existed among different countries or regions.[8] There are no published reports about vasoactive agent titration strategies by Chinese ICU physicians caring for clients with shock. Therefore, this study was conducted to include questions on the selection of vasoactive agents, management during the use of vasoactive agent therapy, monitoring protocols when using these agents, and demographic characteristics of Chinese physicians in ICUs nationwide.

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Methods

Questionnaire development

The survey protocol was used according to the published recommendations for survey methodology.[9] A questionnaire was developed after reviewing previous surveys about the

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use of vasoactive agents[2-5] and a review of the guidelines for vasoactive agent therapy in the treatment of septic, hypovolemic, and cardiogenic shock.[10-12] Focus groups were used to review and refine the questionnaire. It consisted of 18 questions, divided into four parts: Selection of vasoactive agents (items 1–8), management during the use of vasoactive agent therapy (items 9–14), monitoring protocols when using these agents (items 15–16) and demographic characteristics of physicians (items 17–18). The items included binary, nominal, ordinal, and numerical response formats. The questionnaire is accessed via Prof. Jian-Guo Li from Department of Anesthesia and Critical Care, Intensive Care Unit, Emergency Medicine Study Center, Zhongnan Hospital, Wuhan, China.

Data collection

A core group of physician coordinators were selected from the Chinese Society for Critical Care Medicine (CSCCM). This group was selected because they represent 31 regions or provinces in the mainland of China. The coordinators were asked to contact physicians who knew and/or who cared for critically ill adults in an ICU located in whose region or province about participation in this study. The coordinators sent the questionnaire via E-mail to potential participants. Completed questionnaires were then returned to the coordinators and forwarded to the authors of this study. Data collection began on August 17, 2012 and ended on December 30, 2012.

The study was conducted using a questionnaire sent to ICU physicians and no specific data regarding individual patients were collected. The questionnaire was completed and returned anonymously to the authors. The study proposal and questionnaire were submitted for review to the authors' University Ethics Committee, which considered them as exempt of the need for committee approval. Therefore, the research was carried out in compliance with the Helsinki declaration.

Statistical analysis

Data analysis was completed using the Statistical Package for Social Sciences (SPSS 17.0 for Windows) (SPSS Inc., Chicago, IL, USA). Categorical variables are reported by number (percentage), and normally distributed numerical variables as mean (standard deviation [SD]). Categorical variables were analyzed using Chi-square test or Fisher's exact test (for *post-hoc* pair-wise comparison; $P < 0.0125$ was considered as statistically significant). Quantitative variables were compared using *t*-test as normality and homogeneity assumptions were satisfied. Otherwise, the Mann–Whitney *U*-test was used. All comparisons were unpaired, and all tests of significance were two-tailed. For general analysis, a $P < 0.05$ was considered as statistically significant.

Results

The questionnaire was distributed to 900 physicians working in ICU settings. Fifteen questionnaires were excluded from the total of 601 questionnaires returned by participants for the following reasons: Three questionnaires were from physicians working in pediatric settings, five had <75% of the items completed, and seven had identical responses. The response rate of participants for 586 valid questionnaires was 65.1%. This represents participants from 284 intensive care settings (24 medical, 52 surgical, 52 emergency, and 156 general) in 278 hospitals located in 130 cities in China. Participants included 42.3% (248/586) senior staff (>5 years work experience in an ICU); 57.7% (338/586) junior staff (<5 years work experience in an ICU); 67.4% working in 157 teaching hospitals; and 32.6% working in 121 nonteaching hospitals.

Selection of vasoactive agents

Vasopressors

Norepinephrine was selected by 70.8% (415/586) of the respondents for treatment of septic shock, which was significantly higher than the percentages of respondents selecting it for management of either hypovolemic (22.7%, 133/586) or cardiogenic shock (18.9% [111/586]) [Table 1a]. However, dopamine was favored by 73.4% (430/586) and 68.3% (400/586) of the respondents for management of hypovolemic and cardiogenic shock, respectively, but by a lower percentage of respondents selecting it for management of septic shock (27.6% [162/586]) [Table 1a]. A few physicians selected epinephrine as their first choice of vasopressors, but a significantly higher percentage (6.5%, 38/586) chose it for managing cardiogenic shock than for septic (0.9%, 5/586) or hypovolemic shock (1.4% [8/586]) [Table 1a]. Physicians working in teaching hospitals preferred norepinephrine for management of all types of shock at a significantly higher rate than physicians working in nonteaching hospitals [Table 1b]. Yet, physicians from nonteaching hospitals preferred dopamine as their first choice of vasopressors [Table 1b]. A statistically significant difference was not found between senior and junior physicians related to the first choice of vasopressors [Table 1b].

Inotropes

All participants reported their first choice of inotropes for management of septic and cardiogenic shock, but 54.7% (321/586) reported they also used these agents in the management of hypovolemic shock [Tables 2a and b]. Compared with other inotropes, dobutamine was selected as the first choice more frequently for management of the 3 forms of shock: 84.1% (493/586) for septic shock, 64.5% (207/321) for hypovolemic shock, and 60.6% (355/586)

Table 1a: First choice of vasopressor selected by respondents for management of septic, hypovolemic, and cardiogenic shock (n = 586) (n (%))

Vasopressors	Septic	Hypovolemic	Cardiogenic	*P*
Norepinephrine	415 (70.8)	133 (22.7)*	111 (18.9)*	<0.01
Dopamine	162 (27.6)	430 (73.4)*	400 (68.3)*	<0.01
Epinephrine	5 (0.9)	8 (1.4)	38 (6.5)*,†	<0.01
Others	4 (0.7)	15 (2.5)*	37 (6.3)*,†	<0.01

*P<0.01 compared with septic shock; †P<0.01 compared with hypovolemic shock.

Table 1b: Percentage of respondents in selection of vasopressor as the first choice for shock management

Items	Physicians from hospital (*n* (%))		*P*	Staff (*n* (%))		*P*
	T (*n* = 395)	NT (*n* = 191)		Senior (*n* = 248)	Junior (*n* = 338)	
Vasopressors for septic shock						
Norepinephrine	294 (74.4)	121 (63.4)	0.006	180 (72.6)	235 (69.5)	0.422
Dopamine	96 (24.3)	66 (34.6)	0.009	63 (25.4)	99 (29.3)	0.299
Epinephrine	3 (0.8)	2 (1.0)	0.723	3 (1.2)	2 (0.6)	0.655
Others	2 (0.5)	2 (1.0)	0.600	2 (0.8)	2 (0.6)	1.000
Vasopressors for hypovolemic shock						
Norepinephrine	105 (26.6)	28 (14.7)	0.001	57 (23.0)	76 (22.5)	0.887
Dopamine	276 (69.8)	154 (80.6)	0.006	178 (71.8)	252 (74.5)	0.452
Epinephrine	7 (1.8)	1 (0.5)	0.448	4 (1.6)	4 (1.2)	0.727
Others	7 (1.8)	8 (4.2)	0.097	9 (3.6)	6 (1.8)	0.160
Vasopressors for cardiogenic shock						
Norepinephrine	93 (23.5)	18 (9.4)	<0.01	43 (17.3)	68 (20.1)	0.396
Dopamine	253 (64.1)	147 (77.0)	0.002	172 (69.4)	228 (67.5)	0.626
Epinephrine	35 (8.9)	3 (1.6)	0.001	16 (6.5)	22 (6.5)	0.978
Others	14 (3.5)	23 (12.0)	<0.01	17 (6.8)	20 (5.9)	0.520

T: Teaching hospital; NT: Nonteaching hospital.

Table 2a: First choice of inotrope selected by respondents for management of septic, hypovolemic, and cardiogenic shock (*n* (%))

Items	Septic (*n* = 586)	Hypovolemic (*n* = 321)	Cardiogenic (*n* = 586)	*P*
Dobutamine	493 (84.1)	207 (64.5)*	355 (60.6)*	<0.01
Digitalis	70 (11.9)	89 (27.7)*	174 (29.7)*	<0.01
Others	23 (4.0)	25 (7.8)	57 (9.7)*	<0.01

**P*<0.01 compared with septic shock. No significant difference was found between cardiogenic shock and hypovolemic shock.

for cardiogenic shock [Table 2a]. A significantly larger percentage of physicians choosing dobutamine were from teaching hospitals as compared to physicians from nonteaching hospitals. A significantly higher percentage of physicians choosing dobutamine were from teaching hospitals as compared to physicians from nonteaching hospitals [Table 2b]. Following dobutamine, digitalis was the second agent most often selected by physicians. It was selected more often for management of cardiogenic shock (29.7%, 174/586) than for hypovolemic (27.7%, 89/321) or septic shock (11.9% [70/586], $P < 0.01$) [Table 2a]. The percentage of physicians from nonteaching hospitals choosing digitalis to treat all forms of shock were significantly higher than physicians from teaching hospitals [Table 2b]. A significant difference in the first choice of inotropes was not found between senior and junior physicians [Table 2b].

Vasodilators

Vasodilators were more frequently prescribed by physicians in managing cardiogenic shock (67.1%, 393/586) than for septic shock (32.3%, 189/586) and for hypovolemic shock (6.5% [38/586]) [Table 3]. However, a significantly higher percentage of junior physicians, and physicians from nonteaching hospitals reported no use of vasodilators in the management of shock. In addition, the most commonly used vasodilators were the nitroglycerine (71.2%, 417/586), sodium nitroprusside (45.6%, 267/586), and phentolamine (32.9%, 193/586). There was no significant difference in the choice of vasodilators between physicians from teaching and nonteaching hospitals. But, when compared with senior physicians, a significantly low percentage of junior physicians used each of the vasodilators for management of shock [Table 3].

Management in the use of vasopressor/inotropic therapy

Indication and target for use of vasopressor therapy

Nearly half of respondents believed that the mean arterial pressure (MAP) threshold used as an indication for initiation and target for maintenance of vasopressor therapy were the same among the different forms of shock [Table 4]. The percentage of physicians from nonteaching hospitals who answered "yes" for MAP threshold (53.3%, 98/184) and for target (53.3%, 97/182) to these items on the questionnaire was statistically significant when compared with physicians from teaching hospitals who answered "yes" to these same items [Table 4]. A higher mean (SD) value of MAP threshold for the initiation of a vasopressor to treat septic shock was preferred by physicians from teaching hospitals and this was statistically significant when compared with physicians from nonteaching hospitals (64.9 [7.4] vs. 63.0 [7.8] mmHg, $P = 0.005$). But, no statistical differences were found between physicians from teaching and nonteaching hospitals and junior and senior physicians related to the target MAP threshold for maintaining vasopressor therapy [Table 4].

Indication and endpoint for inotropic therapy

The items about indications and endpoints for inotropic therapy allowed for multiple responses. A total of 1840 indications and 2050 endpoint parameters were reported. The primary indications were hypotension (80.2%, 470/586), low CO/cardiac index (*CI*) (66.4%, 389/586), cold extremities (37%, 217/586), and oliguria (30.9%, 181/586) [Table 4]. Parameters used for endpoints included MAP (86.7%, 508/586), urine output (UO) (58.9%, 345/586), CO/CI (50.2%, 294/586),

Table 2b: Percentage of respondents in selection of inotrope as the first choice for shock management

Items	Physicians from hospital		*P*	Staff		*P*
	T (*n* = 395)	NT (*n* = 191)		Senior (*n* = 248)	Junior (*n* = 338)	
Inotropes for septic shock, *n* (%)						
Dobutamine	344 (87.1)	149 (78.0)	0.005	211 (85.1)	282 (83.4)	0.589
Digitalis	37 (9.4)	33 (17.3)	0.006	28 (11.3)	42 (12.4)	0.675
Others	14 (3.5)	9 (4.7)	0.496	9 (3.6)	14 (4.2)	0.752
Do you use inotropes for the treatment of patients with hypovolemic shock? *n* (%)						
Use	205 (51.9)	116 (60.7)	0.044	135 (54.4)	186 (55.0)	0.886
Inotropes for hypovolemic shock, % (*n*/total)						
Dobutamine	70.4 (151/205)	54.9 (56/116)	<0.01	64.4 (87/135)	64.0 (119/186)	0.932
Digitalis	22.1 (44/205)	36.9 (45/116)	0.001	25.2 (34/135)	30.1 (56/186)	0.332
Others	7.5 (10/205)	8.2 (15/116)	<0.01	10.4 (14/135)	5.9 (11/186)	0.141
Inotropes for cardiogenic shock, *n* (%)						
Dobutamine	258 (65.3)	97 (50.8)	0.001	152 (61.3)	203 (60.1)	0.763
Digitalis	98 (24.8)	76 (39.8)	<0.01	64 (25.8)	110 (32.5)	0.078
Others	39 (9.9)	18 (9.4)	0.863	32 (12.9)	25 (7.4)	0.026

T: Teaching hospital; NT: Nonteaching hospital.

Table 3: Choices of vasodilators by respondents

Items	All (*n* = 586)	Physicians from hospital (*n* (%))		*P*	Staff (*n* (%))		*P*
		T (*n* = 395)	NT (*n* = 191)		Senior (*n* = 248)	Junior (*n* = 338)	
Use vasodilators for management of shock							
Never	77 (13.1)	44 (11.1)	33 (17.3)	0.039	12 (4.8)	65 (19.2)	<0.01
Vasodilators for the following type of shock							
Septic	189 (32.3)	123 (31.1)	66 (34.6)	0.407	84 (33.9)	105 (31.1)	0.473
Hypovolemic	38 (6.5)	29 (7.3)	9 (4.7)	0.226	14 (5.6)	24 (7.1)	0.480
Cardiogenic	393 (67.1)	267 (67.6)	126 (66.0)	0.695	23 (9.3)	17 (5.0)	0.650
Choice of vasodilators							
NG	417 (71.2)	290 (73.4)	127 (66.5)	0.072	194 (78.2)	223 (66.0)	0.001
SNP	267 (45.6)	171 (43.3)	96 (50.3)	0.112	130 (52.4)	137 (40.5)	0.004
Phentolamine	193 (32.9)	128 (32.4)	65 (34.0)	0.695	102 (41.1)	91 (26.9)	<0.01
Others	138 (23.5)	94 (23.8)	44 (23.0)	0.839	65 (26.2)	73 (21.6)	0.194

T: Teaching hospital; NT: Nonteaching hospital; NG: Nitroglycerine; SNP: Sodium nitroprusside.

and blood lactate concentration (BLC) (40.8%, 239/586). The percentage of physicians from teaching hospitals who selected a low CO/CI as the indication was significantly higher than physicians from nonteaching hospitals (70.1% [277/395] vs. 58.6% [112/191], $P = 0.006$). Oliguria was selected by more physicians from nonteaching hospitals (39.3% [75/191] vs. 26.8% [106/395], $P = 0.002$) [Table 4]. UO was the only parameter used for the endpoint of inotropic therapy with a greater difference in percentages of physicians from teaching and nonteaching hospitals [Table 4]. There were no differences between senior and junior physicians in the percentages of selecting both the indications and parameters used for endpoints for inotropic therapy.

Use of low-dose dopamine

Some participants (28.3%, 166/586) indicated their preference for low-dose dopamine (1–5 $\mu g \cdot kg^{-1} \cdot min^{-1}$) in the management of shock to improve renal function. The percentage of participants from nonteaching hospitals was higher (35.6%, 68/191) than from teaching hospitals (24.8%, 98/395) and statistically significant ($P = 0.0007$). When comparing junior physicians (30.2%, 102/338) with senior physicians (25.8%, 64/248) regarding the use of low-dose dopamine, a higher percentage was reported but this was not statistically significant ($P = 0.246$) [Table 4].

Monitoring protocol for the use of vasoactive agent therapy

The items on the questionnaire related to routine and advanced monitoring devices/parameters were in multiple response format. All respondents reported that they used electrocardiograph, noninvasive blood pressure (BP), pulse oximetry, and temperature as routine hemodynamic monitoring practices. Other frequently used monitoring devices/parameters included blood gas analysis (98.5%, 577/586), central venous pressure) (87.9%, 515/586), BLC (84.6%, 496/586), and invasive BP (44.2%, 259/586) [Table 5].

Table 4: Management during the use of vasoactive agents for shock management by respondents

Items	All (n = 586)	Physicians from hospital		P	Staff		P
		T (n = 395)	NT (n = 191)		Senior (n = 248)	Junior (n = 338)	
Is MAP threshold the same for the initiation of vasopressors in different types of shock? % (n/total)							
Yes	45.8 (264/577)	42.2 (166/393)	53.3 (98/184)	0.013	43.6 (105/241)	47.3 (159/336)	0.372
Is MAP targeting the same for the use of vasopressors in different types of shock? % (n/total)							
Yes	43.0 (247/575)	38.2 (150/393)	53.3 (97/182)	0.001	36.9 (94/241)	47.3 (153/334)	0.104
MAP threshold in septic shock, mmHg, mean (SD)	64.3 (7.5)	64.9 (7.4)	63.0 (7.8)	0.005	64.6 (8.4)	64.1 (6.9)	0.431
MAP target in septic shock, mmHg, mean (SD)	71.0 (10.8)	71.3 (10.7)	70.6 (11.0)	0.470	70.3 (10.8)	71.6 (10.8)	0.184
The 4 leading indications for inotropic therapy, n (%)							
Hypotension	470 (80.2)	319 (80.8)	151 (79.1)	0.628	197 (79.4)	273 (80.8)	0.689
Low CO/CI	389 (66.4)	277 (70.1)	112 (58.6)	0.006	172 (69.4)	217 (64.2)	0.192
Cold extremities	217 (37.0)	140 (35.4)	77 (40.3)	0.252	86 (34.7)	131 (38.8)	0.312
Oliguria	181 (30.9)	106 (26.8)	75 (39.3)	0.002	83 (33.5)	98 (29.0)	0.247
The leading 4 parameters used for the endpoints in inotropic therapy, n (%)							
MAP	508 (86.7)	349 (88.4)	159 (83.2)	0.088	215 (86.7)	293 (86.7)	0.998
UO	345 (58.9)	221 (55.9)	124 (64.9)	0.039	144 (58.1)	201 (59.5)	0.733
CO/CI	294 (50.2)	206 (52.2)	88 (46.1)	0.168	136 (54.8)	158 (46.7)	0.053
BLC	239 (40.8)	165 (41.8)	74 (38.7)	0.484	110 (44.4)	129 (38.2)	0.132
Use low dose of dopamine, n (%)							
Yes	166 (28.3)	98 (24.8)	68 (35.6)	0.007	64 (25.8)	102 (30.2)	0.246

T: Teaching hospital; NT: Nonteaching hospital; MAP: Mean arterial pressure; CO/CI: Cardiac output/cardiac index; UO: Urine output; BLC: Blood lactate concentration; SD: Standard deviation.

Table 5: Monitoring protocols when using vasoactive agent therapy for shock management by respondents

Items	All (n = 586)	Physicians from hospital (n (%))		P	Staff (n (%))		P
		T (n = 395)	NT (n = 191)		Senior (n = 248)	Junior (n = 338)	
Routinely used monitoring devices/parameters							
ECG	586 (100.0)	395 (100.0)	191 (100.0)	1.000	248 (100.0)	338 (100.0)	1.000
NBP	586 (100.0)	395 (100)	191 (100.0)	1.000	248 (100.0)	338 (100.0)	1.000
SpO_2	586 (100.0)	395 (100)	191 (100.0)	1.000	248 (100.0)	338 (100.0)	1.000
Temperature	586 (100.0)	395 (100)	191 (100.0)	1.000	248 (100.0)	338 (100.0)	1.000
Blood gas analysis	577 (98.5)	391 (99.0)	186 (97.4)	0.160	244 (98.4)	333 (98.5)	1.000
CVP	515 (87.9)	348 (88.1)	167 (87.4)	0.817	224 (90.3)	291 (86.1)	0.121
BLC	496 (84.6)	354 (89.6)	142 (74.3)	<0.01	212 (85.5)	284 (84.0)	0.628
IBP	259 (44.2)	186 (47.1)	73 (38.2)	0.043	109 (44.0)	150 (44.4)	0.918
Often used advanced monitoring devices/parameters							
PICCO	134 (22.9)	106 (26.8)	28 (14.7)	<0.01	51 (20.6)	83 (24.6)	0.256
PAC	21 (3.6)	19 (4.8)	2 (1.0)	0.022	10 (4.0)	11 (3.3)	0.617
TEE	2 (0.3)	2 (0.5)	0 (0)	1.000	2 (0.8)	0 (0)	0.179
GMMM	3 (0.5)	3 (0.8)	0 (0)	0.555	3 (1.2)	0 (0)	0.075
SMM	3 (0.5)	3 (0.8)	0 (0)	0.555	3 (1.2)	0 (0)	0.075

T: Teaching hospital; NT: Nonteaching hospital; ECG: Electrocardiograph; NBP: Noninvasive blood pressure; SpO_2: Pulse oximetry; IBP: Invasive blood pressure; CVP: Central venous pressure; PICCO: Pulse index contour continuous cardiac output; PAC: Pulmonary artery catheter; TEE: Transesophageal echocardiography; GMMM: Gastric mucosal microcirculatory monitoring; SMM: Sublingual microcirculatory monitoring; BLC: Blood lactate concentration.

Advanced monitoring devices/parameters were investigated in this survey. The most often used was pulse index contour continuous CO (PICCO) chosen by 26.8% (106/395) of respondents from teaching hospitals and 14.7% (28/191) in nonteaching hospitals ($P < 0.001$) [Table 5]. Other advanced monitoring devices/parameters, including pulmonary artery

catheter (PAC), transesophageal echocardiography, gastric mucosal microcirculatory monitoring, and sublingual microcirculatory monitoring, were chosen by <5% of respondents [Table 5]. There was no statistically significant difference between senior and junior physicians. PICCO and PAC were used more often in teaching hospitals than in nonteaching hospitals [Table 5].

Discussion

An important finding is that most of the respondents followed the recommendations on the first choice of vasoactive agents found in current guidelines for the management of septic shock but compliance with guidelines for the first choice of vasoactive agents in management of hypovolemic and cardiogenic shock was very low. Like ICU colleagues from around the world, Chinese intensivist physicians have updated their knowledge on the use of vasoactive agents used to treat septic shock in the past two decades. There are three editions of evidence-based guidelines for international use in the management of severe sepsis and septic shock[10,13,14] which are available based on the SSC. This information has been spread to Chinese ICU physicians through presentations at annual national congresses, publication of the guidelines in Chinese versions[15] and is available on the website of the CSCCM[16] and in other media forms. Thus, the authors believed that the achieved 70.8% and 84.1% of compliance with the guidelines on the first choice of vasopressors (in selection of norepinephrine) [Table 1a] and inotropes (in selection of dobutamine) [Table 2a] for septic shock was more likely based on these nationwide education strategies, although the rates were still below those reported by Lamontagne *et al*.[17] among Canadian physician intensivists.

By contrast, the selection of norepinephrine was low as the first choice of a vasopressor for treating hypovolemic and cardiogenic shock [Table 1a]. In fact, norepinephrine has increasingly proven to be of benefit in the management of hypovolemic and cardiogenic shock by either venous α or β_2-adrenergic stimulation[18-20] and decreases myocardial oxygen consumption in situations of tachycardia and tachyarrhythmias.[21,22] It is also recommended as the first choice of vasopressors in European guidelines for the management of hemorrhagic and cardiogenic shock.[11,12] However, these guidelines have not been widely accepted to the same degree as those for septic shock. This may be partially explained by the lower numbers of patients with either cardiogenic shock or hypovolemic shock than the number of patients with septic shock in ICU settings.[23] It may more likely be explained by physicians not paying enough attention to the recommendations for hypovolemic and cardiogenic shock management. This finding reinforces that systematic education could lead to a significant change in physicians' behavior.

Another important research finding is that physicians from nonteaching hospitals were more likely to make inappropriate choices (noncompliance with guidelines or the latest evidence) regarding the use of vasopressor agents in shock management than physicians from teaching hospitals. For instance, dopamine was chosen by many physicians from nonteaching hospitals as their first choice of a vasopressor and low-dose dopamine was used to improve renal function. Dopamine is not recommended as a first-line vasopressor agent for the treatment of shock due to its potential increase in the rate of patient mortality and the incidence of arrhythmias.[7,21,24,25] Evidence-based research from over 10 years ago also indicates that low-dose dopamine has no effect on renal protection.[26-28] Regarding physician preference in the first choice of inotropes for shock management, findings in this study revealed that dobutamine was more frequently prescribed by physicians from a teaching hospital, and physicians from nonteaching hospitals preferred to use digitalis in the management of each form of shock. Digitalis is characterized as having both positive and negative inotropic effects, and has been traditionally used to improve cardiac function in patients with chronic heart disease.[29] It has never been recommended for management of any type of shock[29-31] and has a very limited role in the current management of cardiogenic shock.[29] In contrast, current shock management guidelines recommend that dobutamine be administered in the presence of myocardial dysfunction.[10-12] Chinese physicians in nonteaching hospitals also made inappropriate choices related to indications or targets for use of vasopressors and inotropes, the use of vasodilators, and seldom used advanced monitoring techniques when compared with their colleagues in teaching hospitals. It appears that physicians in nonteaching hospitals lacked knowledge about the updated guidelines on shock management which may account for their having selected inappropriate vasoactive agents. This finding may be explained by the fact that teaching hospitals serve as training and research centers where knowledge of updated clinical practices may be available through participation in education programs, academic exchanges, and presentation of research findings. Physicians in nonteaching hospitals may not have adequate accesses to these resources on a regular basis. However, senior and junior physicians in a same ICU setting can share similar viewpoints. This explains why no differences were found between senior and junior physicians in this survey. This may be a challenge in all ICU settings, not just those in China. As a result of this second finding, there is a need to increase knowledge of and use of practice guidelines by ICU physicians in nonteaching hospitals. Education programs or implementation of quality indicators should involve more physicians in nonteaching hospitals to improve their awareness and acceptance of these guidelines; and uniform written protocols for management of patients with shock should be developed and put into practice for all teaching and nonteaching hospitals.

There are several limitations when interpreting the data from this study. First, the data are self-reported and not observed, leading to the possibility of reporter bias. Second, the method of identifying participants might have introduced an element of selection bias, but no other method was available to obtain a representative sample. However, the respondents in this survey represented ICU physicians from a broad spectrum of geographical areas and different types of ICUs in China.

Third, the survey included a limited number of questions, therefore, some specific or important issues relevant to use and management of vasoactive therapy in shock might have been overlooked. The questionnaire does not ask about some of the latest and most current monitoring strategies.

In conclusion, discrepancies exist in the use of vasoactive agent therapy by Chinese physicians in intensive care settings. It appears that the majority of Chinese physicians in ICUs follow the recommended guidelines related to the first-line choice of vasoactive agents when managing patients with septic shock. But, the rate of compliance with first-line vasoactive agent therapy, when managing patients with hypovolemic and cardiogenic show, is very low. Both senior and junior physicians in nonteaching hospitals are more apt to select inappropriate choices about the use of vasoactive medications than the same groups of physicians from teaching hospital ICUs. These research findings suggest that physicians lack information on the evidence-based guidelines for the management of clients in shock, and this contributed to varied practices in the selection and titration of vasoactive agents. As a result, education resources and programs about vasoactive therapy in shock management are suggested for all physicians.

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