

Clinical Characteristics and Current Interventions in Shock Patients in Chinese Emergency Departments: A Multicenter Prospective Cohort Study

Shu-Bin Guo¹, Yun-Xia Chen¹, Xue-Zhong Yu²

¹Emergency Department, Beijing Chao-Yang Hospital Affiliated to Capital Medical University, Beijing 100020, China

²Emergency Department, Peking Union Medical College Hospital, Beijing 100730, China

Abstract

Background: Shock is a life-threatening condition in emergency departments (EDs) and is associated with a high mortality; however, its clinical characteristics and current interventions in China are seldom reported. This study investigated the clinical characteristics and current interventions of shock patients in Chinese EDs.

Methods: This multicenter prospective cohort study was conducted in the EDs of 33 academic hospitals in 16 Chinese provinces. Adult shock patients were enrolled from December 2013 to April 2014. Age, sex, comorbidities, shock subtype, and vital signs were recorded on ED arrival; details of subsequent interventions and treatments were added. We compared those data between survivors and nonsurvivors. All patients were followed up for 3 days. The primary outcome was 3-day mortality. Binary logistic regression analysis identified the independent predictors of that mortality.

Results: We enrolled 1095 shock patients. The 3-day mortality was 27.5%, 36.3%, and 29.0%, respectively, in the whole cohort and for cardiogenic and septic shock. Within the first 24 h, 1039 patients (94.9%) were admitted to the Intensive Care Unit. Use of bicarbonate, epinephrine, and dopamine is an independent predictor for mortality. Hemorrhage and trauma (39.1%), along with sepsis (40.4%) were the most commonly observed causes of shock in the ED. In nondiabetic patients with cardiogenic shock, 3-day mortality was 69.2% for patients needing glucose control — much higher than in those not needing glucose control (30.0%, $P = 0.01$). Hydroxyethyl starch (HES) was applied in 29.6% of septic shock patients, and the mortality of septic patients who received HES was much higher than those who did not (38.2% vs. 25.1%, $P = 0.006$).

Conclusions: In China, short-term mortality of shock patients in EDs is still high, especially among those with cardiogenic and septic shock. HES application needs to be restricted — particularly in septic shock patients.

Key words: Emergencies; Mortality; Sepsis; Shock; Therapeutics

INTRODUCTION

Shock is a life-threatening condition, and it usually demands that a patient should be initially admitted to an emergency department (ED). The condition is associated with a high mortality rate.^[1-3] Shock is most commonly divided into the following types: septic, cardiogenic, hemorrhagic, traumatic, neurogenic, burn, and anaphylactic. The clinical characteristics vary greatly from one subtype to another, but the initial resuscitation measures are similar. They include fluid resuscitation, vasopressor application, inotropic therapy, and supportive management. Although shock is a classic critical syndrome encountered in the ED, the clinical characteristics, current interventions, and short-term outcomes with certain types of shock have been little investigated or reported;

other types, for example, septic and cardiogenic shock, have been investigated in some depth. Management guidelines have been developed for shock patients, and adherence to those guidelines does improve outcomes.^[4] However, the compliance of ED physicians in China to such guidelines has seldom been reported. The present observational study was

Address for correspondence: Prof. Xue-Zhong Yu,
Emergency Department, Peking Union Medical
College Hospital, Beijing 100730, China
E-Mail: yuxuezhongxh@163.com

This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as the author is credited and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

© 2017 Chinese Medical Journal | Produced by Wolters Kluwer - Medknow

Received: 10-02-2017 **Edited by:** Yuan-Yuan Ji
How to cite this article: Guo SB, Chen YX, Yu XZ. Clinical Characteristics and Current Interventions in Shock Patients in Chinese Emergency Departments: A Multicenter Prospective Cohort Study. *Chin Med J* 2017;130:1146-54.

Access this article online

Quick Response Code:



Website:
www.cmj.org

DOI:
10.4103/0366-6999.205862

designed to reveal the characteristics, current interventions, and short-term outcomes of the various types of shock in patients in Chinese EDs.

METHODS

Ethical approval

The Chinese Medical Doctors' Association (CMDA) Ethics Committee approved the study. We obtained written informed consent for participation from all patients or their relatives.

Study setting and design

This multicenter prospective cohort study was designed by the CMDA and was conducted in the EDs of 33 large academic hospitals located in 16 Chinese provinces. One investigator assessed patients together with the ED physician when a patient with suspected shock arrived at the ED. The ED physician made the diagnosis and selected the intervention. We compiled details of the enrollment decision, case report form, and follow-up, but we were not involved in the diagnosis or interventions. Statisticians blinded to the data collection procedures performed the statistical analyses.

Study cohort and grouping

We screened consecutive patients who visited the ED with suspected shock from December 2013 to April 2014. The inclusion criteria were as follows: age ≥ 18 years; new-onset hypotension unexplained by any other known cause; and signs of tissue hypoperfusion, including tachycardia (except neurogenic shock in which the heart rate was not fast), oliguria (urine output of <0.5 ml/kg body weight for 1 h), mottled skin, and altered mental state. Hypotension was defined as fulfilling one of the two criteria: (1) systolic blood pressure (SBP) <90 mmHg, diastolic blood pressure (DBP) <60 mmHg, or mean arterial pressure (MAP) <65 mmHg; (2) a decrease in SBP of >40 mmHg from baseline in a hypertensive patient. If the baseline blood pressure could not be confirmed, hypotension was diagnosed according to the absolute blood pressure at the time of enrollment. We excluded patients from the study who did not agree to complete the investigation. Figure 1 shows flowchart of the patient screening and enrollment.

We categorized the enrolled patients into six groups according to etiologic factors: septic shock; hemorrhagic and traumatic shock; cardiogenic shock; neurogenic shock; anaphylactic shock; and burn shock. And then, we divided the cohort into patients with and without risk factors, and compared the mortality between them.

Data collection

General information about the enrolled patients was recorded at the time of ED arrival; it comprised age, sex, telephone number, medical ID, comorbid conditions, vital signs, and shock subtype. All interventions that the enrolled patients underwent in the ED (including standard treatments and major interventions specific to the type of shock) were recorded; they included the following: resuscitation fluids, antibiotics, vasopressors, inotropic therapy, corticosteroids,

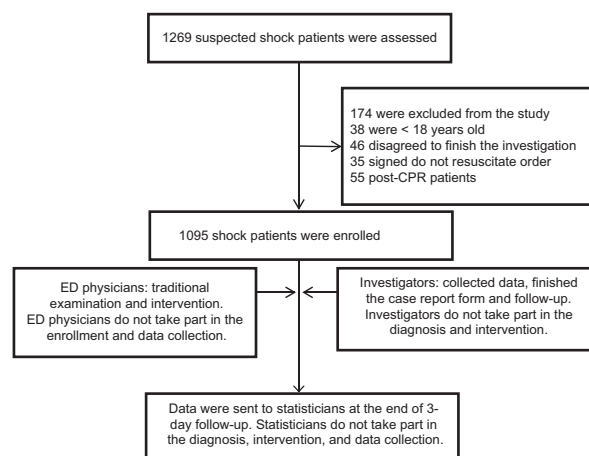


Figure 1: Flowchart of the screening and enrollment of the patients.

glucose control, hemodynamic monitoring, red blood cell (RBC) transfusion, bicarbonate usage, proton pump inhibitor (PPI) administration, renal replacement therapy, mechanical ventilation (MV), and emergency surgery. The Modified Early Warning Score (MEWS) was calculated as an illness severity assessment for every enrolled patient on ED arrival.^[5] We compared those data between survivors and nonsurvivors.

Comorbidity definitions and previous medical history

We defined cardiovascular disease (CVD) as angina or prior myocardial infarction. We defined arrhythmia as a nonsinus rhythm with clinical symptoms. Hypertension was defined as definitive hypertension and taking antihypertensive medication. The definition of chronic congestive heart failure was any New York Heart Association class. We defined hyperlipidemia as blood lipid levels exceeding the normal laboratory range. Cerebral infarction was defined as ischemic stroke. The definition of cerebral hemorrhage was vascular hemorrhage in any intracerebral location. Tumor was defined as malignant solid neoplasm. We defined diabetes mellitus (DM) as previously established DM, and we included both insulin-dependent and noninsulin-dependent types. Cholelithiasis was defined as stones formed in either the gallbladder or bile duct. Urinary calculus included the presence of kidney, ureteral, or vesicular calculi. We defined surgery as any prior surgical procedure. The definition of allergy was an allergic reaction to any suspected allergen.

Outcome variables

Through their medical records, all patients were followed up for 3 days after enrollment. The primary outcome was 3-day mortality. Admission to the Intensive Care Unit (ICU) within the first 24 h was the secondary outcome.

Statistical analysis

We analyzed all data using SPSS software, version 16.0 (SPSS Inc., Chicago, IL, USA). Data with a normal distribution were expressed as mean \pm standard deviation and were analyzed using an independent-samples *t*-test. Data with a skewed distribution were expressed as median (quartile) and were analyzed using Mann–Whitney *U*-test. We used

the Chi-square test for comparison of frequencies. We employed binary logistic regression analysis to identify independent predictors of mortality. All statistical tests were two tailed, and we considered $P < 0.05$ to indicate statistical significance.

RESULTS

Clinical characteristics of study cohort

In all, 1269 patients were evaluated during the enrollment period. Subsequently, 174 patients were excluded from the study, and the study enrolled 1095 shock patients [Figure 1]. Within the first 24 h, 1039 patients (94.9%) were admitted to the ICU. The 3-day mortality of the whole cohort was 27.5%; it was higher in patients with cardiogenic shock (36.3%) or septic shock (29.0%) than with others. Among the enrolled patients, the diagnoses were as follows: 442 as septic shock (40.4%); 428 as hemorrhagic and traumatic shock (39.1%); 168 as cardiogenic shock (15.3%); 28 as neurogenic shock (2.6%); 15 as anaphylactic shock (1.4%); and 14 as burn shock (1.3%).

The clinical characteristics of the patients are shown in Table 1. The most frequent chronic comorbidity was hypertension, which occurred in 31.2% of the cohort. Chronic comorbidities, which included CVD, arrhythmias, hypertension, congestive heart failure, hyperlipidemia, and DM, were seen more frequently in patients with cardiogenic and septic shock.

The vital signs of the study cohort are shown in Table 1. The highest armpit temperature was seen in septic patients. The highest heart rate occurred in patients with burn shock. We observed the highest respiratory rate in patients with septic and burn shock. MAP was lower in patients with septic shock than in others. The lowest transcutaneous oxygen saturation was seen with cardiogenic shock.

Interventions and treatments

The interventions and treatments for the enrolled patients are shown in Table 2. Of the whole cohort, 94.3% of patients received fluid resuscitation in the ED, 90.6% of patients received crystalloids, and 46.1% of patients received colloids. Hydroxyethyl starch (HES) was used in 29.6% of septic shock patients.

Vascular active agents were used in 64.3% of patients. Vasopressors accounted for the majority (64.0%); dobutamine was used in just 3.0% of patients. Hemodynamic monitoring was conducted in 57.4% of patients; it was most frequently applied in those with anaphylactic, cardiogenic, or septic shock. Antibiotics were used in 58.3% of the cohort and 95% of the septic shock patients in the ED. Of the whole cohort, 50.1% of patients received a PPI, especially those with neurogenic, hemorrhagic, or septic shock. Several specific interventions, such as anti-allergy measures, emergency surgery, and RBC transfusion, were more frequently used as etiologic treatment in patients with anaphylactic, hemorrhagic, or traumatic shock. Glucose control was

undertaken more frequently in patients with neurogenic or septic shock than in those with other shock types. MV was applied in 32.7% of the cohort; its use was greater in patients with cardiogenic, neurogenic, or septic shock. The incidence of continuous renal replacement therapy (CRRT) was 3.7% of the whole cohort; it mainly occurred in patients with neurogenic or septic shock.

Risk factors of mortality

The risk factors those significantly differed between survivors and nonsurvivors are shown in Table 3, along with the mortality and relative risk ratio. The variables that showed no difference between survivors and nonsurvivors are not shown in Table 3. With respect to mortality, cardiogenic shock patients had a high risk, whereas those with anaphylactic shock had a low risk. High-risk factors for mortality in the ED were tumor, MEWS >5 , use of bicarbonate, HES, or second-choice vasopressor, and MV. In contrast, receiving RBC transfusion, emergency surgery, and use of Ringer's lactate tended to decrease mortality in the ED.

In patients with septic shock, tumor was clearly a high-risk factor, whereas CVD and cerebral hemorrhage were not. In such patients, use of HES, bicarbonate, or second-choice vasopressors was related to higher mortality than application of Ringer's lactate. The mortality of septic patients who received HES was much higher than those who did not (38.2% vs. 25.1%, $P = 0.006$). In patients with hemorrhagic and traumatic shock, RBC transfusion and emergency surgery tended to decrease mortality. In patients diagnosed with cardiogenic shock, glucose control was a high-risk factor of mortality. When we divided the cohort into patients with and without prior DM, the 3-day mortality differed between the glucose control and nonglucose control groups only for nondiabetic cardiogenic shock patients [Table 3].

None of the parameters for the 28 patients with neurogenic shock showed a statistical difference between survivors ($n = 22$) and nonsurvivors ($n = 6$). There were 15 survivors and no nonsurvivors of anaphylactic shock and 12 survivors and two nonsurvivors of burn shock. Since these numbers were low, we did not undertake statistical analyses for these patients.

Independent predictors of mortality

The independent predictors of mortality identified by logistic regression are shown in Table 4. For the whole cohort, the predictors of increasing mortality in the ED included a prior tumor and the use of bicarbonate or second-choice vasopressor. The application of Ringer's lactate was associated with decreased mortality. Cardiogenic and anaphylactic shock were high-risk factors for mortality; however, they were not independent predictors of mortality.

For septic shock, use of second-choice vasopressor independently predicted increased mortality; the application of Ringer's lactate was related to decreased mortality. For hemorrhagic and traumatic shock, a MEWS score >5 and use

Table 1: Characteristics of enrolled shock patients

Parameters	Whole cohort (n = 1095)	Septic shock (n = 442)	Hemorrhagic and traumatic shock (n = 428)	Cardiogenic shock (n = 168)	Neurogenic shock (n = 28)	Anaphylactic shock (n = 15)	Burn shock (n = 14)
Age (years)	59 ± 19	64 ± 18	52 ± 18	65 ± 18	56 ± 16	52 ± 20	49 ± 15
Male, n (%)	688 (62.8)	267 (60.4)	296 (69.2)	93 (55.4)	17 (60.7)	7 (46.7)	8 (57.1)
Comorbidities and past medical history, n (%)							
CVD	143 (13.1)	66 (14.9)	24 (5.6)	49 (29.2)	3 (10.7)	1 (6.7)	0
Arrhythmia	70 (6.4)	38 (8.6)	5 (1.2)	27 (16.1)	0	0	0
Hypertension	342 (31.2)	154 (34.8)	99 (23.1)	69 (41.1)	10 (35.7)	6 (40.0)	4 (28.6)
CHF	59 (5.4)	32 (7.2)	7 (1.6)	19 (11.3)	1 (3.6)	0	0
Hyperlipidemia	27 (2.5)	12 (2.7)	6 (1.4)	8 (4.8)	1 (3.6)	0	0
Diabetes mellitus	156 (14.2)	73 (16.5)	44 (10.3)	35 (20.8)	2 (7.1)	2 (13.3)	0
Cerebral hemorrhage	25 (2.3)	18 (4.1)	3 (0.7)	2 (1.2)	2 (7.1)	0	0
Cerebral infarction	62 (5.7)	37 (8.4)	14 (3.3)	9 (5.4)	1 (3.6)	1 (6.7)	0
Tumor	78 (7.1)	44 (10.0)	25 (5.8)	6 (3.6)	1 (3.6)	2 (13.3)	0
Cholelithiasis	25 (2.3)	19 (4.3)	4 (0.9)	1 (0.6)	1 (3.6)	0	0
Urinary calculus	16 (1.5)	12 (2.7)	1 (0.2)	1 (0.6)	2 (7.1)	0	0
Surgery	128 (11.7)	74 (16.7)	31 (7.2)	17 (10.1)	3 (10.7)	3 (20.0)	0
Allergy	30 (2.7)	16 (3.6)	7 (1.6)	3 (1.8)	1 (3.6)	3 (20.0)	0
Healthy	365 (33.3)	101 (22.9)	199 (46.5)	39 (23.2)	11 (39.3)	5 (33.5)	10 (71.4)
Armpit temperature (°C)	36.7 (36.1–37.5)	37.0 (36.3–38.4)	36.5 (36.0–37.0)	36.5 (36.0–37.0)	36.5 (35.8–37.8)	36.5 (36.5–37.0)	36.2 (36.0–37.2)
Heart rate (beats/min)	110 (95–125)	111 (99–126)	110 (100–124)	107 (84–128)	70 (61–75)	109 (91–128)	115 (107–120)
Respiratory rate (beats/min)	22 (19–25)	23 (20–28)	21 (19–24)	21 (18–26)	20 (17–22)	20 (19–24)	23 (20–28)
SBP (mmHg)	78 (71–85)	78 (70–85)	79 (73–86)	78 (70–87)	76 (67–89)	80 (79–87)	85 (74–91)
DBP (mmHg)	48 (40–55)	46 (40–54)	50 (41–56)	49 (40–56)	49 (40–56)	57 (43–68)	51 (47–56)
MAP (mmHg)	58 (52–65)	57 (51–63)	60 (52–65)	59 (50–65)	59 (49–67)	67 (53–73)	63 (53–67)
SpO ₂ (%)	94 (87–97)	93 (85–97)	95 (90–98)	90 (83–96)	91 (85–99)	95 (85–98)	96 (94–98)
MEWS	5 (4–7)	5 (4–7)	5 (4–6)	5 (4–6)	4 (3–5)	4 (3–5)	5 (4–6)

Data were shown as mean ± SD, n (%) or median (quartile). CVD: Cardiovascular disease; CHF: Chronic heart failure; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; MAP: Mean arterial pressure; SpO₂: Transcutaneous oxygen saturation; MEWS: Modified Early Warning Score; SD: Standard deviation.

of second-choice vasopressor indicated a diverse outcome; however, RBC transfusion was associated with a better outcome. For cardiogenic shock, glucose control and use of second-choice vasopressor were independent predictors of mortality.

DISCUSSION

The present investigation was a large multicenter study that comprehensively examined the clinical characteristics, interventions, and outcomes of shock patients in China.

The present study revealed the etiologic characteristics and short-term outcome of shock in Chinese EDs. Hemorrhagic and traumatic shock, along with septic shock accounted for the majority of shock cases. One multicenter randomized trial which was conducted in eight centers in Belgium, Austria, and Spain in ICU shock patients reported a much higher proportion of septic shock (62.2%) and lower proportion of hemorrhagic and traumatic shock (15.7%).^[2] The difference

between our findings and those may relate to the different cohort. The previous study reported a similar short-term mortality to what we observed. The 3-day mortality was not directly reported in that earlier investigation; however, it may be deduced from Kaplan–Meier curves for 28-day survival.

In the present study, hypertension was the most frequent chronic comorbidity in the entire cohort, reflecting its high incidence and chronic nature in China.^[6] The high incidence of hypertension should prompt ED physicians to exercise caution with the blood pressure cutoff value when diagnosing shock. In hypertensive patients, blood pressure below baseline may be of more diagnostic importance than a specific value. One recent study found that the shock index, which included hypertension, was an independent predictor of 30-day mortality in a broad population of ED patients.^[7] In the present study, the baseline blood pressures of some patients were not definitive; thus, we used instead the absolute blood pressure value. This diagnostic strategy may result in delayed recognition

Table 2: Interventions, treatments, and outcomes of the study cohort (n (%))

Interventions	Whole cohort (n = 1095)	Septic shock (n = 442)	Hemorrhagic and traumatic shock (n = 428)	Cardiogenic shock (n = 168)	Neurogenic shock (n = 28)	Anaphylactic shock (n = 15)	Burn shock (n = 14)
Antibiotics	638 (58.3)	420 (95.0)	147 (34.3)	52 (31.0)	13 (46.4)	1 (6.7)	5 (35.7)
Glucocorticoid	177 (16.2)	86 (19.5)	67 (15.7)	9 (5.4)	5 (17.9)	5 (33.3)	5 (35.7)
Ulinastatin	121 (11.1)	89 (20.1)	22 (5.1)	5 (3.0)	4 (14.3)	0	1 (7.1)
Glucose control	154 (14.1)	76 (17.2)	47 (11.0)	23 (13.7)	5 (17.9)	1 (6.7)	2 (14.3)
Hemodynamic monitoring	629 (57.4)	271 (61.3)	223 (52.1)	105 (62.5)	17 (60.7)	11 (73.3)	2 (14.3)
Bicarbonate	257 (23.5)	119 (26.9)	76 (17.8)	57 (33.9)	4 (14.3)	0	1 (7.1)
Proton pump inhibitor	549 (50.1)	240 (54.3)	223 (52.1)	65 (38.7)	15 (53.6)	1 (6.7)	5 (35.7)
Red blood transfusion	352 (32.1)	56 (12.7)	279 (65.2)	6 (3.6)	3 (10.7)	0	8 (57.1)
Anti-allergy	23 (2.1)	5 (1.1)	5 (1.2)	1 (0.6)	0	12 (80.0)	0
Emergency surgery	118 (10.8)	18 (4.1)	83 (19.4)	12 (7.1)	2 (7.1)	0	3 (21.4)
Resuscitation fluids	1033 (94.3)	422 (95.5)	418 (97.7)	143 (85.1)	24 (85.7)	12 (80.0)	14 (100)
Colloids	505 (46.1)	214 (48.4)	231 (54.0)	38 (22.6)	12 (42.9)	4 (26.7)	6 (42.9)
Albumin	152 (13.9)	88 (19.9)	44 (10.3)	15 (8.9)	3 (10.7)	0	2 (14.3)
Dextran	71 (6.5)	26 (5.9)	33 (7.7)	9 (5.4)	1 (3.6)	2 (13.3)	0
Hydroxyethyl starch	324 (29.6)	131 (29.6)	161 (37.6)	15 (8.9)	10 (35.7)	2 (13.3)	5 (35.7)
Succinylated gelatin	61 (5.6)	14 (3.2)	40 (9.3)	7 (4.2)	0	0	0
Crystalloids	992 (90.6)	409 (92.5)	403 (94.2)	133 (79.2)	23 (82.1)	10 (66.7)	14 (100)
0.9% saline	963 (87.9)	401 (90.7)	389 (90.9)	130 (77.4)	22 (78.6)	10 (66.7)	11 (78.6)
Ringer's lactate	525 (47.9)	203 (45.9)	254 (59.3)	47 (28.0)	7 (25.0)	1 (6.7)	13 (92.9)
Vascular active agents	704 (64.3)	322 (72.9)	207 (48.4)	142 (84.5)	21 (75.0)	8 (53.3)	4 (28.6)
Vasopressors	701 (64.0)	319 (72.2)	207 (48.4)	142 (84.5)	21 (75.0)	8 (53.3)	4 (28.6)
Norepinephrine	282 (25.8)	150 (33.9)	85 (19.9)	39 (23.2)	5 (17.9)	0	3 (21.4)
Epinephrine	182 (16.6)	55 (12.4)	61 (14.3)	55 (32.7)	5 (17.9)	6 (40.0)	0
Dopamine	505 (46.1)	234 (52.9)	142 (33.2)	106 (63.1)	18 (64.3)	2 (13.3)	3 (21.4)
Dobutamine	30 (2.7)	13 (2.9)	4 (0.9)	13 (7.7)	0	0	0
Organ function support							
Mechanical ventilation	358 (32.7)	166 (37.6)	98 (22.9)	79 (47.0)	12 (42.9)	0	3 (21.4)
CRRT	40 (3.7)	27 (6.1)	5 (1.2)	6 (3.6)	2 (7.1)	0	0
Outcomes							
ICU admission	1039 (94.9)	422 (95.5)	408 (95.3)	155 (92.3)	27 (96.4)	13 (86.7)	14 (100.0)
3-day mortality	301 (27.5)	128 (29.0)	104 (24.3)	61 (36.3)	6 (21.4)	0	2 (14.3)

CRRT: Continuous renal replacement therapy; ICU: Intensive Care Unit.

of shock, leading to diverse outcomes — especially for patients with cardiogenic shock.

The present study revealed both merits and deficiencies in interventions and treatments of shock. The first merit was that the management of shock was progressive and complete in the investigated EDs. Basic resuscitation management (including fluid resuscitation, vasopressors, inotropic agents, and MV) was applied in a timely fashion. More complex, invasive interventions were also initiated in EDs, such as CRRT and invasive hemodynamic monitoring. Second, 95% of septic shock patients received antibiotics in the ED; this management strongly adheres to the current guidelines.^[8] We also found that more survivors than nonsurvivors received antibiotics in the ED. This result emphasizes the importance of early administration of antibiotics for better outcomes; the finding is in accordance with those of numerous studies.^[9] Third, more than half of the patients with neurogenic, septic, or hemorrhagic and traumatic shock were administered a PPI in the ED. However, a recent meta-analysis indicated that, although

PPIs were more effective than histamine H2-receptor antagonists for stress ulcer prophylaxis in critically ill patients, the quality and quantity of evidence supporting the use of PPIs in adult ICU patients are low.^[10,11]

An obvious deficiency in the treatment of septic shock found in the present study was excessive use of HES. We found that employing HES was associated with higher mortality. According to the Surviving Sepsis Campaign guidelines, the application of HES during septic shock results in a high incidence of CRRT, and it has no survival advantages compared with crystalloid solutions.^[8] One meta-analysis, which included 11 randomized control trials, did not find a dose–effect relationship of HES with mortality in septic shock patients.^[12] The authors concluded that an inappropriate daily positive fluid balance was probably an important source of heterogeneity in those trials, which reported that HES was associated with excess mortality in septic patients. Although in the present study HES application was not an independent predictor of mortality in septic patients, its usage should be limited because of its renal injury effect.

Table 3: Risk factors of mortality

Risk factors	3-day mortality		RR	χ^2	P
	With risk factor (%)	Without risk factor (%)			
The whole cohort (n = 1095)					
Cardiogenic shock	36.3	25.9	1.40	7.747	0.005
Anaphylactic shock	0	27.9		5.765	0.016
Tumor	42.3	26.4	1.60	9.253	0.002
MEWS >5	33.1	23.6	1.40	12.116	<0.001
Bicarbonate	42.0	23.0	1.83	35.593	<0.001
Red blood transfusion	22.4	29.9	0.75	6.625	0.010
Emergency surgery	14.4	29.1	0.49	11.36	0.001
HES	32.1	25.6	1.25	4.907	0.027
Ringer's lactate	21.1	33.3	0.63	20.375	<0.001
Second-choice vasopressor	39.2	15.1	2.60	79.818	<0.001
Mechanical ventilation	37.7	22.5	1.68	27.877	<0.001
Septic shock (n = 442)					
CVD	18.2	30.9	0.59	4.380	0.036
Cerebral hemorrhage	5.6	30.0	0.19	4.996	0.025
Tumor	47.7	26.9	1.77	8.366	0.004
Antibiotics	27.9	50.0	0.56	4.982	0.026
Bicarbonate	43.7	23.5	1.86	17.193	<0.001
HES	38.2	25.1	1.52	7.674	0.006
Ringer's lactate	18.7	37.7	0.50	19.135	<0.001
Second-choice vasopressor	39.0	15.7	2.48	28.713	<0.001
Hemorrhagic and traumatic shock (n = 428)					
MEWS >5	33.8	19.0	1.78	11.721	0.001
Bicarbonate	35.5	21.9	1.62	6.332	0.012
Red blood transfusion	18.6	34.9	0.53	13.963	<0.001
Emergency surgery	12.0	27.2	0.44	8.401	0.004
Norepinephrine	32.9	22.2	1.48	4.306	0.038
Second-choice vasopressor	41.2	14.2	2.90	39.914	<0.001
Mechanical ventilation	44.9	18.2	2.47	29.319	<0.001
Cardiogenic shock (n = 168)					
Glucose control	60.9	32.4	1.88	6.951	0.008
Diabetes mellitus (n = 35)	50.0	44.0	1.14	0.104	>0.05
Nondiabetic (n = 133)	69.2	30.0	2.31	8.064	0.01
Bicarbonate	47.7	30.6	1.56	4.562	0.033
Second-choice vasopressor	42.3	20.0	2.12	7.070	0.008

Second-choice vasopressors: Any of epinephrine and dopamine. RR: Relative risk; MEWS: Modified Early Warning Score; CVD: Cardiovascular disease; HES: Hydroxyethyl starch.

Another deficiency we identified was overuse of dopamine, especially in cardiogenic, neurogenic, and septic shock. One reason for this may be the lack of a central venous catheter on ED arrival. We also found that, in refractory shock patients, dopamine was used in addition to norepinephrine as a vasopressor. A nationwide survey of Chinese ICUs reported that 70.8% of ICU physicians selected norepinephrine and 27.6% selected dopamine as the first choice of vasopressor for septic shock patients; however, the actual usage level was not clear.^[13] In the same study, dopamine was selected by 73.4% of physicians for hypovolemic shock and 68.3% of physicians for cardiogenic shock as the first-choice vasopressor. Dopamine has previously been recommended as the first choice for cardiogenic shock.^[1] However, recent American Heart Association/American College of Cardiology guidelines expressed doubt about dopamine-related

increased mortality among patients in cardiogenic shock induced by non-ST-elevation acute coronary syndrome.^[14] One meta-analysis concluded that no difference in mortality could be found between norepinephrine and dopamine in hypotensive shock; however, a large multicenter randomized trial demonstrated that, compared with norepinephrine, the use of dopamine was associated with a greater number of adverse events and significantly increased 28-day mortality in cardiogenic shock patients.^[2,15]

The present study found an interesting problem. In cardiogenic shock patients without DM, the need for glucose control was associated with a high mortality rate. In this study, glucose control measures were initiated when two consecutive blood glucose levels exceeded 11 mmol/L. The target glucose level was 8.3 mmol/L. According to this protocol, the requirement for glucose control was an

Table 4: The independent predictors of 3-day mortality

Independent predictors	B	SE	Wald	P	OR	95% CI for OR	
						5%	95%
The whole cohort							
Tumor	0.618	0.255	5.890	0.015	1.855	1.126	3.055
Bicarbonate	0.606	0.160	14.259	<0.001	7.832	1.338	2.509
Ringer's lactate	-0.482	0.146	10.970	0.001	0.617	0.464	0.821
Second-choice vasopressor	1.103	0.154	51.072	<0.001	3.014	2.227	4.079
Constant	-1.616	0.144	125.361	<0.001	0.199		
Septic shock							
Ringer's lactate	-1.005	0.232	18.806	<0.001	0.366	0.232	0.576
Second-choice vasopressor	1.269	0.243	27.373	<0.001	3.557	2.211	5.723
Constant	-1.291	0.214	36.493	<0.001	0.275		
Hemorrhagic and traumatic shock							
MEWS >5	0.679	0.249	7.428	0.006	1.971	1.210	3.212
Red blood transfusion	-0.982	0.904	0.007	<0.001	0.374	0.230	0.611
Second-choice vasopressor	1.389	0.247	31.681	<0.001	4.012	2.473	6.508
Constant	-1.461	0.231	39.848	<0.001	0.232		
Cardiogenic shock							
Glucose control	1.171	0.474	6.099	0.014	3.226	1.273	8.171
Second-choice vasopressor	1.071	0.423	6.417	0.011	2.917	1.274	6.679
Constant	-1.555	0.388	16.085	<0.001	0.211		

Second-choice vasopressors: Any of epinephrine and dopamine. SE: Standard error; OR: Odds ratio; CI: Confidence interval; MEWS: Modified Early Warning Score.

indirect indicator of high glucose level during ED residence. One study revealed that admission blood glucose level was an independent predictor of increased risk of mortality in patients with ST-segment elevation myocardial infarction in cardiogenic shock; however, that result was found only among nondiabetic patients.^[16] The mechanism is not clear, and our finding needs to be verified with a larger population.

This study has several limitations. First, it involved six shock subtypes that develop very different clinical features because of their varying pathophysiology. Most of the variables investigated were general and not specific for a certain subtype of shock. Second, we included few clinical factors, for example, laboratory results, which led to difficulties when addressing interventions and treatments. Third, most of the parameters were binary and influenced the accuracy of statistical analysis. Fourth, there were few patients with burn, neurogenic, or anaphylactic shock; with such patients, most of the variables did not differ between survivors and nonsurvivors. Our findings for those patients should be verified in larger studies.

Despite those limitations, we believe that our results provide at least an overview of shock for practitioners in both China and other countries. We focused on initial interventions and treatments in EDs; we expect that this area will become more of an issue in real-world practice in the future, and we consider that our work makes a contribution in this regard.

In China, short-term mortality among shock patients in EDs is still high — especially in those with cardiogenic and septic shock. HES application should be further restricted — particularly among septic shock patients.

Acknowledgments

The authors sincerely thank Prof. Si-Yan Zhan and Dr. Ru Chen for their excellent assistance with the statistical analyses. The authors also thank the ED and investigating staffs at each center for their helpful contributions to the study.

Collaborators

Tan-Shi Li¹; Fei Pan¹; Li-Pei Yang²; Qiu-Yan Yan²; Guo-Xing Wang²; Yi Li³; Sheng-Yong Xu³; Ya-An Zheng⁴; Wei Huai⁴; Xu-Yan Chen⁵; Xiao-Jing Li⁵; Ji-Hong Zhu⁶; Xin-Chao Zhang⁷; Fan Wang⁷; Rong-Bin Zhou⁸; Yuan-Bo Zhang⁸; Yu Wang⁹; Jian-Hong Liu⁹; Heng-Bo Gao¹⁰; Ying-Li Jin¹⁰; Jian-Guo Li¹¹; Su-Yan Li¹¹; Wei-Zhan Wang¹²; Ya-Qin Li¹²; Rui-Juan Lyu¹³; Ru-Gang Liu¹³; Shi-Nan Nie¹⁴; Bao-Di Sun¹⁴; Qing-Lin Rui¹⁵; Yi-Jun Wang¹⁵; Zheng Zhang¹⁶; Hua Shen¹⁶; Yu Cao¹⁷; Chuan-Xi Chen¹⁷; Chuan-Yun Qian¹⁸; Wei Zhang¹⁸; Zhong Shi¹⁹; Xia Li¹⁹; En-Qiang Mao²⁰; Wei-Jun Zhou²⁰; Xian-Zheng Wu²¹; Gang Guo²¹; Mei-Qi Zhang²²; Huan Chen²²; Mao Zhang²³; Zhong-Qiu Lu²⁴; Dong Wu²⁴; Ke-Dong Xue²⁵; Yan He²⁵; Ping Rao²⁶; Ji-Wei Fu²⁶; Ze-Song Luo²⁶; Wei-Yi Qin²⁷; Fan Lin²⁷; Hong-Ke Zeng²⁷; Xin-Qiang Liu²⁸; Wen Yin²⁹; Wei Zhao²⁹; Jun-Kai Du³⁰; Xiao-Qin Yang³¹; Jian-Ping Wang³¹; Pei-Wu Li³²; Yong-Gang Ding³²; Li-Shan Yang³³; Jia-Li Wu³³; Si-Yan Zhan³⁴; Ru Chen³⁴

¹Emergency Department, Chinese People's Liberation Army General Hospital, Beijing 100853, China;

²Emergency Department, Beijing Friendship Hospital, Capital Medical University, Beijing 100050, China;

³Emergency Department, Peking Union Medical College Hospital, Beijing 100730, China;

⁴Emergency Department, Peking University Third Hospital, Beijing 100191, China;

⁵Emergency Department, Peking University First Hospital, Beijing 100034, China;

⁶Emergency Department, Peking University People's Hospital, Beijing 100044, China;

⁷Emergency Department, Beijing Hospital, Beijing 100730, China;

⁸Emergency Department, The Military General Hospital of Beijing PLA, Beijing 100700, China;

⁹Emergency Department, Tianjin First Center Hospital, Tianjin 300192, China;

¹⁰Emergency Department, The Second Hospital of Hebei Medical University, Shijiazhuang, Hebei 050000, China;

¹¹Emergency Department, Hebei General Hospital, Shijiazhuang, Hebei 050051, China;

¹²Emergency Department, Harrison International Peace Hospital, Shijiazhuang, Hebei 050000, China;

¹³Emergency Department, Qilu Hospital of Shandong University, Jinan, Shandong 250012, China;

¹⁴Emergency Department, Nanjing General Hospital, Nanjing, Jiangsu 210002, China;

¹⁵Emergency Department, Jiangsu Province Hospital of TCM, Affiliated Hospital of Nanjing University of TCM, Nanjing, Jiangsu 210029, China;

¹⁶Emergency Department, Nanjing First Hospital, Nanjing, Jiangsu 210006, China;

¹⁷Emergency Department, West China Hospital, Sichuan University, Chengdu, Sichuan 610041, China;

¹⁸Emergency Department, First Affiliated Hospital of Kunming Medical University, Kunming, Yunnan 650032, China;

¹⁹Emergency Department, Xinqiao Hospital, Third Military Medical University, Chongqing 400037, China;

²⁰Emergency Department, Ruijin Hospital Shanghai Jiao Tong University School of Medicine, Shanghai 200025, China;

²¹Emergency Department, Tongji Hospital of Tongji University, Shanghai 430030, China;

²²Emergency Department, Zhejiang Provincial People's Hospital, Hangzhou, Zhejiang 310014, China;

²³Emergency Department, The Second Affiliated Hospital of Zhejiang University School of Medicine, Hangzhou, Zhejiang 310009, China;

²⁴Emergency Department, The First Affiliated Hospital of Wenzhou Medical University, Wenzhou, Zhejiang 325000, China;

²⁵Emergency Center, The Xinjiang Uygur Autonomous Region People's Hospital, Urumqi, Xinjiang 830001, China;

²⁶Emergency Department, Affiliated Hospital of Hainan Medical University, Haikou, Hainan 570102, China;

²⁷Emergency Department, General Hospital of Guangzhou Military Command of PLA, Guangzhou, Guangdong 510010, China;

²⁸EICU, Guangdong General Hospital, Guangzhou, Guangdong 510080, China;

²⁹Emergency Department, Xijing Hospital, The Fourth Military Medical University, Xi'an, Shanxi 710032, China;

³⁰Emergency Department, The First Affiliated Hospital of Xi'an Jiaotong University, Xi'an, Shanxi 710061, China;

³¹Emergency Department, Gansu Provincial Hospital, Lanzhou, Gansu 730000, China;

³²Emergency Center, Lanzhou University Second Hospital, Lanzhou, Gansu 730030, China;

³³Emergency Department, General Hospital of Ningxia Medical University, Yinchuan, Ningxia 750004, China;

³⁴School of Public Health, Peking University, Beijing 100191, China.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Topalian S, Ginsberg F, Parrillo JE. Cardiogenic shock. *Crit Care Med* 2008;36 1 Suppl:S66-74. doi: 10.1097/01.CCM.0000296268.57993.90.
2. De Backer D, Biston P, Devriendt J, Madl C, Chochrad D, Aldecoa C, *et al.* Comparison of dopamine and norepinephrine in the treatment of shock. *N Engl J Med* 2010;362:779-89. doi: 10.1056/NEJMoa0907118.
3. Angus DC, van der Poll T. Severe sepsis and septic shock. *N Engl J Med* 2013;369:840-51. doi: 10.1056/NEJMra1208623.
4. Levy MM, Rhodes A, Phillips GS, Townsend SR, Schorr CA, Beale R, *et al.* Surviving Sepsis Campaign: Association between performance metrics and outcomes in a 7.5-year study. *Crit Care Med* 2015;43:3-12. doi: 10.1097/CCM.0000000000000723.
5. Subbe CP, Kruger M, Rutherford P, Gemmel L. Validation of a modified Early Warning Score in medical admissions. *QJM* 2001;94:521-6. doi: 10.1093/qjmed/94.10.521.
6. Gao Y, Chen G, Tian H, Lin L, Lu J, Weng J, *et al.* Prevalence of hypertension in China: A cross-sectional study. *PLoS One* 2013;8:e65938. doi: 10.1371/journal.pone.0065938.
7. Kristensen AK, Holler JG, Hallas J, Lassen A, Shapiro NI. Is shock index a valid predictor of mortality in emergency department patients with hypertension, diabetes, high age, or receipt of β - or calcium channel blockers? *Ann Emerg Med* 2016;67:106-13.e6. doi: 10.1016/j.annemergmed.2015.05.020.
8. Dellinger RP, Levy MM, Rhodes A, Annane D, Gerlach H, Opal SM, *et al.* Surviving sepsis campaign: International guidelines for management of severe sepsis and septic shock: 2012. *Crit Care Med* 2013;41:580-637. doi: 10.1097/CCM.0b013e31827e83af.
9. Sterling SA, Miller WR, Pryor J, Puskarich MA, Jones AE. The

- impact of timing of antibiotics on outcomes in severe sepsis and septic shock: A systematic review and meta-analysis. *Crit Care Med* 2015;43:1907-15. doi: 10.1097/CCM.0000000000001142.
10. Alhazzani W, Alenezi F, Jaeschke RZ, Moayyedi P, Cook DJ. Proton pump inhibitors versus histamine 2 receptor antagonists for stress ulcer prophylaxis in critically ill patients: A systematic review and meta-analysis. *Crit Care Med* 2013;41:693-705. doi: 10.1097/CCM.0b013e3182758734.
 11. Krag M, Perner A, Wetterslev J, Wise MP, Hylander Møller M. Stress ulcer prophylaxis versus placebo or no prophylaxis in critically ill patients. A systematic review of randomised clinical trials with meta-analysis and trial sequential analysis. *Intensive Care Med* 2014;40:11-22. doi: 10.1007/s00134-013-3125-3.
 12. Ma PL, Peng XX, Du B, Hu XL, Gong YC, Wang Y, *et al.* Sources of heterogeneity in trials reporting hydroxyethyl starch 130/0.4 or 0.42 associated excess mortality in septic patients: A systematic review and meta-regression. *Chin Med J* 2015;128:2374-82. doi: 10.4103/0366-6999.163387.
 13. Pei XB, Ma PL, Li JG, Du ZH, Zhou Q, Lu ZH, *et al.* Extensive variability in vasoactive agent therapy: A nationwide survey in Chinese Intensive Care Units. *Chin Med J* 2015;128:1014-20. doi: 10.4103/0366-6999.155064.
 14. Amsterdam EA, Wenger NK, Brindis RG, Casey DE Jr., Ganiats TG, Holmes DR Jr., *et al.* 2014 AHA/ACC guideline for the management of patients with non-ST-elevation acute coronary syndromes: A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. *Circulation* 2014;130:e344-426. doi: 10.1161/CIR.0000000000000134.
 15. Havel C, Arrich J, Losert H, Gamper G, Müllner M, Herkner H. Vasopressors for hypotensive shock. *Cochrane Database Syst Rev* 2011;5:CD003709. doi: 10.1002/14651858.CD003709.
 16. Yang JH, Song PS, Song YB, Hahn JY, Choi SH, Choi JH, *et al.* Prognostic value of admission blood glucose level in patients with and without diabetes mellitus who sustain ST segment elevation myocardial infarction complicated by cardiogenic shock. *Crit Care* 2013;17:R218. doi: 10.1186/cc13035.