Original Article

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

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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...
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 screening and enrollment of the patients.

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, 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 ± 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
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%).[5] 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...
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. 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. 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.

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. One meta-analysis, which included 11 randomized control trials, did not find a dose–effect relationship of HES with mortality in septic shock patients. 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 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 = 20) | 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 (53.7)                 | 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.
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 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 27.6% 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 measures was 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 3: Risk factors of mortality

| Risk factors                          | 3-day mortality | RR   | $\chi^2$ | P     |
|---------------------------------------|-----------------|------|----------|-------|
|                                       | With risk factor (%) | Without risk factor (%) |       |       |
| The whole cohort ($n=1095$)           | 36.3            | 25.9 | 1.40     | 7.747 | 0.005 |
| Cardiogenic shock                     | 0               | 27.9 | 1.60     | 9.253 | 0.002 |
| Anaphylactic shock                    | 33.1            | 23.6 | 1.40     | 12.116| <0.001|
| Tumor                                 | 42.0            | 23.0 | 1.83     | 35.593| <0.001|
| MEWS >5                               | 22.4            | 29.9 | 0.75     | 6.625 | 0.010 |
| Bicarbonate                           | 14.4            | 29.1 | 0.49     | 11.36 | 0.001 |
| Red blood transfusion                 | 32.1            | 25.6 | 1.25     | 4.907 | 0.027 |
| Emergency surgery                     | 21.1            | 33.3 | 0.63     | 20.375| <0.001|
| MEWS >5                               | 33.1            | 23.6 | 1.40     | 12.116| <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|
| Septic shock ($n=442$)                | 18.2            | 30.9 | 0.59     | 4.380 | 0.036 |
| CVD                                   | 5.6             | 30.0 | 0.19     | 4.969 | 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 ($n=428$) | 33.8          | 19.0 | 1.78     | 11.721| 0.001 |
| MEWS >5                               | 35.5            | 21.9 | 1.62     | 6.332 | 0.012 |
| Bicarbonate                           | 18.6            | 34.9 | 0.53     | 13.963| <0.001|
| Red blood transfusion                 | 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 ($n=168$)           | 60.9            | 32.4 | 1.88     | 6.951 | 0.008 |
| Glucose control                       | 50.0            | 44.0 | 1.14     | 0.104 | >0.05 |
| Diabetes mellitus ($n=35$)            | 69.2            | 30.0 | 2.31     | 8.064 | 0.01  |
| Nondiabetic ($n=133$)                 | 47.7            | 30.6 | 1.56     | 4.562 | 0.033 |
| Bicarbonate                           | 42.3            | 20.0 | 2.12     | 7.070 | 0.008 |
| Second-choice vasopressor             |                |      |          |       |

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

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**Collaborators**

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There are no conflicts of interest.

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