Critical care medicine (CCM) is a clinical medicine discipline that studies the occurrence and development of life-threatening diseases and their diagnosis and treatment. Intensive care units (ICUs) are the clinical base of intensive care medicine, providing systematic and high-quality medical monitoring and treatment for patients with dysfunction of one or multiple organs caused by various life-threatening or potentially high-risk factors. ICUs use advanced diagnostic, monitoring, and treatment technologies to continuously and dynamically monitor patient conditions and provide standardized, high-quality life support to critically ill patients to improve their quality of life through effective intervention. The life support technical level of ICUs directly reflects the comprehensive treatment ability of hospitals, which is an important symbol of modern hospitals. The construction of the critical care medicine discipline and ICU management should meet the relevant national standards.

To promote the development of critical care medicine and standardize ICU management, this guideline was developed.

1. Essential requirements
   1.1 Grade-III hospitals and equipped grade-II hospitals should establish departments of critical care medicine, which is an independent clinical discipline directly affiliated with hospitals’ functional departments. The ICU is the clinical base of the Department of Intensive Care Medicine.
   1.2 The ICU must be installed with a sufficient number of professionals who have been specially trained, have basic critical care medical knowledge and skills, and have the ability to work independently.
1.3 The ICU should configure the necessary monitoring and treatment equipment and receive critically ill patients from all departments.

2. The size of the ICU

The number of beds in the ICU is determined by the grade of hospital and the hospital’s requirements. Generally, the ICU accounts for 2%-8% of the total number of hospital beds and can be adjusted according to hospital needs. From the perspective of operation, each ICU unit preferably has 8-12 beds, and the usage rate is 65%-75%. A usage rate over 80% indicates that the number of beds cannot meet the clinical needs and should be expanded.

3. Staffing

3.1 The ratio of the number of ICU specialists to the number of beds should be more than 0.8-1:1. ICU work team members should include three classes of physicians: superior, mediocre, and inferior. At least one superior physician in each unit should be fully responsible for medical work.

3.2 The ratio of the number of ICU nurses to the number of beds should be more than 2.5-3:1.

3.3 If necessary, the ICU can be staffed with an appropriate number of medical support personnel and related technical and maintenance workers.

4. Requirements for ICU health care professionals

4.1 ICU medical staff should have strict professional theoretical and technical training to meet critical care needs.

4.2 ICU specialists must receive standardized professional training.

4.3 ICU specialists must have theoretical knowledge related to critical care and master the relevant physiology, pathology and pathophysiology of important organs and systems, have clinical pharmacology knowledge and understand ethical concepts related to the ICU.

4.4 ICU specialists should master the theory and skills related to organs and systemic function monitoring and support in critically ill patients, including ① resuscitation; ② shock; ③ respiratory failure; ④ heart failure, severe arrhythmia; ⑤ acute renal
insufficiency; central nervous system dysfunction; severe liver dysfunction; gastrointestinal dysfunction and gastrointestinal bleeding; acute coagulopathy; severe endocrine and metabolic disorders; water, electrolytes and acid-base balance disorders; intestinal and parenteral nutrition support; sedative and analgesic; severe infection; multiple organ dysfunction syndrome; and immune dysfunction.

4.5 In addition to general clinical monitoring and treatment techniques, ICU specialists should have the ability to independently perform the following monitoring and support technologies: cardiopulmonary resuscitation; artificial airway establishment and management; mechanical ventilation techniques; fiberoptic bronchoscopy; deep vein and arterial catheterization technique; hemodynamic monitoring technique; thoracentesis, pericardiocentesis and thoracic close drainage; cardioversion and defibrillation; bedside temporary cardiac pacing; blood purification technology; and methods for assessing the severity of disease.

4.6 ICU physicians participate in at least one provincial or major medically related continuing medical education and training program each year and continue to receive knowledge updates.

4.7 ICU nurses must undergo rigorous professional training, master the basic theories and skills related to intensive care, and pass independent examinations to be independent.

5. Medical management in the ICU

5.1 The ICU department must establish and improve various rules and regulations, develop the responsibilities of various personnel, and standardize the routine of diagnosis and treatment. The following should be developed to ensure the quality of medical service: medical quality control system; diagnosis and treatment and medical care operation routine; patient transfer in and out of ICU system; antibiotic use system; blood and blood product use system; rescue equipment operation and management system; special drug management system; in-hospital infection control system; adverse medical event prevention and reporting system;
difficult and critically ill patient consultation system; doctor-patient communication system; and plan for emergency and emergency call-out system.

5.2 The patients in the ICU should be the charge of the ICU specialist. Other specialists are also involved in treatment decisions if necessary.

5.3 Treatment range of ICU

5.3.1 Patients with acute, reversible, life-threatening organ dysfunction and those who may recover in the short term after ICU monitoring and intensive treatment.

5.3.2 There are a variety of high-risk factors that can be life-threatening and are monitored by the ICU and treated at any time to reduce the risk of death.

5.3.3 Patients with acute exacerbations on the basis of chronic organ dysfunction may be restored to their original state after close monitoring and treatment by the ICU.

5.3.4 Patients with end-stage conditions of chronic wasting disease, those with irreversible disease, and those who are unable to benefit from ICU monitoring and therapy are generally not eligible for ICU admission.

6. ICU construction standard

6.1 The ICU should be located in a geographic area convenient for patient transfer, examination and treatment, and the location should be close to the main service target wards, operating room, medical imaging department, clinical laboratory and blood bank, etc.

6.2 Each ICU open bed covers 15-18 square meters. Each ICU should be equipped with a minimum of 1 single ward with an area of 18-25 square meters. Generally, each ICU is equipped with 1 to 2 negative pressure isolation wards. Under the condition of sufficient human resources, as many single wards should be set up as possible.

6.3 Auxiliary rooms in the ICU include the doctor’s office, director’s office, staff lounge, central workstation, treatment room, dispensing room, instrument room, dressing room, clean room, sewage treatment room, duty room, restroom and so on. Some conditional ICUs can be configured with other auxiliary rooms, including classrooms, family reception rooms, laboratories, and nutrition preparation rooms. The ratio of the auxiliary room area to the ward area should be 1.5:1 or higher.
6.4 Each functional area of the room should be relatively independent to reduce mutual interference and infection.

6.5 The ICU should have good ventilation and lighting conditions. Some conditional ICUs are best equipped with an air purification system to control the temperature and humidity. The temperature in the clinical area should be maintained at approximately 24±1.5 ℃. One set of inductive hand washing facilities and hand disinfection devices should be installed for each single ward, and at least 2 sets should be installed for every 2 open beds.

6.6 The ICU should have reasonable personnel and item flow paths to minimize interference and cross-infection.

6.7 The building decor in the ICU must follow the general principles of preventing dust, resisting corrosion, and being moistureproof, static-free, easy to clean, and fireproof.

6.8 The ICU should be designed to allow convenient observations for medical staff and to reach patients as soon as possible.

6.9 In addition to the patient’s pager and the warning sound of the monitoring instrument, other noise should be reduced as much as possible. According to the recommendations of the International Noise Association, the daytime noise in the ICU should not exceed 45 dB(A), 40 dB(A) in the afternoon, and 20 dB(A) at night. Use sound-absorbing materials for roofs and walls.

6.10 The ICU should establish a complete communication system, network and clinical information management system, and broadcasting system.

7. Necessary equipment in the ICU

7.1 A function rack is required for each bed unit to provide functions such as electricity, oxygen, compressed air and vacuum suction. Each bed unit should be equipped with at least 12 power outlets, 2 oxygen interfaces, 2 compressed air ports and 2 vacuum suction ports. Medical power and life lighting wires should be relatively independent. The power for each ICU bed should be supplied by a separate feedback circuit. A spare uninterruptible power system (UPS) and earth leakage
protection should be established. Ideally, each socket should have its own short-circuiter on the main panel.

7.2 A bed suitable for ICU use should be equipped with a mattress to prevent bedsores.

7.3 Each bed should be equipped with a bedside monitoring system for basic vital signs such as ECG, blood pressure, pulse oximetry, and invasive pressure. At least one portable monitor is available for transfer.

7.4 Grade III hospitals should be equipped with a ventilator and simple breathing apparatus (resuscitation air bag) for each bed. At least one portable ventilator should be available for transfer in each ICU. Grade II hospitals can configure the corresponding number of ventilators according to their needs.

7.5 Each bed should be equipped with an infusion pump, at least 2 microinjection pumps and adequate enteral feeding pumps.

7.6 Other equipment: Electrocardiograph, blood gas analyzer, defibrillator, blood purification machine, continuous hemodynamic and oxygen metabolism detection equipment, cardiopulmonary resuscitation equipment, external pacemaker, fiberoptic bronchoscope, electronic lifting and cooling equipment, etc.

7.7 The hospital should provide the necessary bedside ultrasound examination, X-ray examination, biochemical and bacteriological examination, etc.

8. Elective equipment in the ICU

① Simple biochemical and lactic acid analyzer; ② CCTV visitation system;
③ Bispectral index monitor; ④ infusion heating equipment; ⑤ Gastric mucosa carbon dioxide tension and pHi meter; ⑥ End-expiratory carbon dioxide detector; ⑦ ECMO; ⑧ EEG and intracranial pressure monitor; ⑨ IABP and left ventricular assist device; ⑩ Counterpulsation device to prevent DVT; and ⑪ Chest shock drainage device.
Document 2. Medical quality control indicators for critical care medicine (2015)

1. The proportion of ICU patients within total inpatients (%) and the proportion of ICU bed occupancy within total inpatient bed occupancy (%)

**Definition of the proportion of ICU inpatients within total inpatients (%):** The total number of patients admitted to the ICU within the number of patients admitted to the hospital during the same period.

The proportion of ICU patients within total inpatients (%) = the total number of patients admitted to the ICU/the total number of patients admitted to the hospital during the same period × 100%

**Definition of the proportion of ICU bed occupancy within total inpatient bed occupancy (%):** The total bed occupancy of ICU inpatients within the total inpatient bed occupancy of the hospital during the same period.

The proportion of ICU in total inpatient bed occupancy( % ) = the total inpatient bed occupancy of the ICU/the total inpatient bed occupancy of the hospital during the same period × 100%

Meaning of these two parameters: To reflect the proportion and hospital course of ICU patients within all hospitalized patients.

2. The proportion of patients with an Apache II score ≥ 15 within all ICU patients(%) (within 24 hours after being admitted to the ICU)

**Definition:** The total number of patients whose Apache II score is equal to or greater than 15 points within the total number of patients admitted to the ICU within 24 hours after being admitted.

The proportion of patients with Apache II scores ≥ 15 within all ICU patients( % ) (within 24 hours after being admitted to the ICU) = the total number of patients whose Apache II scores are equal to or greater than 15 points within 24 hours after being admitted to the ICU/the total number of patients admitted to the ICU in the same period.

Meaning: To reflect the severity of illness in patients admitted to the ICU.

Note: A hospital with an information collection system could generate the
APACHE II score automatically and stratify it according to <10 points, 10-15 points, 15-20 points, 20-25 points, and >25 points.

3. 3-hour SSC bundle compliance (\%)

**Definition:** The 3-hour SSC bundle includes measuring lactate levels, obtaining blood cultures prior to administration of antibiotics, administering broad spectrum antibiotics and administering 30 ml/kg crystalloid for hypotension or lactate \( \geq 4 \) mmol/L within 3 hours. The 3-hour SSC bundle completion rate refers to the number of patients admitted to the ICU who were diagnosed with septic shock and who completed the 3-h bundle within the total number of patients admitted to the ICU who were diagnosed with septic shock. New cases of septic shock during ICU admission were excluded.

The 3-hour SSC bundle completion rate = the number of patients admitted to the ICU who were diagnosed with septic shock and completed the 3-h bundle/the total number of patients admitted to the ICU who were diagnosed with septic shock in the same period \( \times 100\% \)

**Meaning:** To reflect the clinical standardization and medical care capacity of septic shock.

4. 6-hour SSC bundle compliance (\%)

**Definition:** The 6-hour SSC bundle involves, in addition to the 3-hour bundle, applying vasopressors (for hypotension that does not respond to initial fluid resuscitation) to maintain a mean arterial pressure of 65 mm Hg, measuring central venous pressure (CVP) and central venous oxygen saturation (ScvO2) in the event of persistent arterial hypotension despite volume resuscitation (septic shock) or initial lactate \( \geq 4 \) mmol/L (36 mg/dL) and re-measuring lactate if the initial lactate was elevated.

The 6-hour SSC bundle completion rate refers to the number of patients admitted to the ICU who were diagnosed with septic shock and who completed 6h bundles within the total number of patients admitted to the ICU who were diagnosed with septic shock. New cases of septic shock during ICU admission were excluded.

The 6-hour SSC bundle completion rate = the number of patients admitted to the ICU who were diagnosed with septic shock and completed 6-h bundles/the total number of patients admitted to the ICU who were diagnosed with septic shock in the same period \( \times 100\% \)
Meaning: To reflect the clinical standardization and medical care capacity for septic shock.

5. Microbiology detection rate before antibiotics(%)  
**Definition:** The number of ICU inpatients with microbiology detection before antibacterial agent treatment within the total number of inpatients using antibiotics for therapeutic purposes. Microbiology detection includes several microbiological cultures, procalcitonin, interleukin-6 and other serologic testing of infection indicators.

Microbiology detection rate before antibiotics=the number of cases with microbiology detection before antibacterial agent treatment/the total number of ICU inpatients using antibiotics for therapeutic purposes in the same period × 100%

Meaning: To reflect the normative use of antibiotics in the ICU.

6. The proportion of DVT prophylaxis(%)  
**Definition:** The number of inpatients in the ICU with DVT prophylaxis within the total number of inpatients in the ICU in the same period. The optimal mode of DVT prophylaxis includes pharmacological prophylaxis (heparin or LMWH), mechanical prophylaxis (intermittent pneumatic leg compression or elastic stockings) and inferior vena cava filter.

The proportion of DVT prophylaxis(%)=the number of inpatients in the ICU with DVT prophylaxis/the total number of inpatients in the ICU×100%

Meaning: To assess DVT prophylaxis for ICU patients.

7. Observed mortality rate and expected mortality rate  
**Definition:** Expected mortality predicted by disease severity (assessed by APACHE II score). Formula for patient death risk (R): In (R/(1-R))=-3.517+ (APACHE II score×0.146) +0.603 (only for patients after emergency surgery) + the main disease score of the patient admitted to the ICU (according to international standards), the number of inpatients in the ICU with DVT prophylaxis within the total number of inpatients in the ICU in the same period. Expected mortality rate in the ICU: the total expected mortality rate for ICU inpatients within the total number of ICU inpatients at the same time.

Expected mortality rate=the total number of expected mortalities of ICU inpatients/the total number of ICU inpatients×100%

Meaning: To reflect the disease severity of ICU inpatients and to calculate the
Patient Standardized Mortality Index.

8. Standardized Mortality Ratio

**Definition:** The calibrated case fatality rate, adjusted for severity of disease, is the ratio of the actual mortality rate of ICU patients to the expected mortality rate of ICU patients in the same period. The actual mortality rate of ICU patients refers to the ratio of the number of patients discharged due to irreversible diseases and the number of inpatients admitted to the ICU in the same period. Patients with clinical brain death at admission and patients admitted to the ICU for organ donation were excluded.

Standardized mortality ratio = actual mortality rate of ICU patients / expected mortality rate of ICU patients

**Meaning:** Reflecting the integral level of the ICU.

9. Unplanned extubation in the ICU

**Definition:** The number of unplanned extubation cases within the total number of extubations in ICU patients.

Unplanned extubation in the ICU = the number of unplanned extubation cases / the total number of extubations within ICU patients

**Meaning:** Reflecting the integral management and treatment level of ICUs.

10. Extubation failure, as defined by reintubation or within 48 h after extubation

**Definition:** The number of re-intubations within 48 hours after extubation (except for unplanned extubation) within the total number of extubation cases in the ICU in the same period.

Re-intubation within 48 h after extubation = the number of re-intubations within 48 hours after extubation / the total number of extubation cases in the ICU

**Meaning:** Reflecting the judgement of proper extubation indication in the ICU.

11. Unplanned ICU transfer rate

**Definition:** An unplanned ICU transfer refers to a transfer without early warning or no plan for ICU transfer post-surgery prior to the initiation of anesthesia induction. It is determined as transfer to the ICU during or after surgery. The unplanned ICU transfer rate refers to the number of unplanned ICU transfer patients within the total number of inpatients admitted to the ICU. The reasons for unplanned ICU transfer should be stratified according to the lack of early warning, anesthesia factors or surgical factors.

Unplanned ICU transfer rate = the number of unplanned ICU transfer patients / the total number of inpatients admitted to the ICU
Meaning: One of the outcome indicators reflecting the quality of medical care in medical institutions.

12. Readmission rate after ICU discharge within 48 hrs

**Definition:** The number of patients returning to the ICU within 48 hours after discharge from the ICU within the total number of patients discharged from the ICU.

Readmission rate after ICU discharge within 48 hrs = the number of patients returning to the ICU within 48 hours after discharge from ICU/the total number of patients discharged from the ICU.

Meaning: Reflecting the judgement of proper discharge indication in the ICU.

13. Ventilator-associated pneumonia (VAP) morbidity in the ICU

**Definition:** The number of cases of VAP in the ICU within the total sum of the days each patient was put on invasive mechanical ventilation in the same period (unit: per thousand mechanical ventilation days)

VAP morbidity in ICU = the number of cases of VAP in the ICU/the total sum of days each patient was put on invasive mechanical ventilation

Meaning: To reflect the capability of infection control, invasive mechanical ventilation and disease management in the ICU.

14. Catheter related blood stream infection (CRBSI) morbidity in the ICU

**Definition:** The number of cases of CRBSI in the ICU within the total sum of days each patient had indwelling intravascular catheters in the same period.

CRBSI morbidity in ICU = the number of cases of CRBSI in the ICU/the total sum of days each patient had indwelling intravascular catheters.

Meaning: To reflect the capability of infection control, intravascular catheter indwelling and disease management in the ICU.

15. Catheter associated urinary tract infection rates (CAUTI) morbidity in the ICU

**Definition:** The number of cases of CAUTI in the ICU within the total sum of days each patient had an indwelling catheter in the same period.

CAUTI morbidity in ICU = the number of cases of CAUTI in ICU/the total sum of days each patient had an indwelling catheter

Meaning: To reflect the capability of infection control, urinary catheter indwelling and disease management in the ICU.

Note: The medical quality control indicators for critical care medicine apply to all types of intensive care units, including MICU, EICU, RICU, CCU, etc, except for PICU.
### Supplementary Table 1: Summary of erroneous data.

| Type of errors | Parameters to determine erroneous data |
|----------------|----------------------------------------|
| Illogical data | ICU bed occupancy was greater than total bed occupancy in hospital and total bed occupancy was 0 |
|                | The total number of patients admitted to ICU was greater than the total number of patients admitted to the hospital |
|                | The total number of inpatients bed occupancy of ICU was greater than inpatient bed occupancy of the whole hospital |
|                | The total number of patients with an APACHE II score ≥15 points was greater than the total number of patients admitted to ICU |
|                | The number of inpatients who performed microbiology detection before antibacterial agents treatment was greater than the total number of ICU inpatients using antibiotics for therapeutic purpose |
|                | The number of patients admitted to ICU with a diagnosis of septic shock and completed 3 h bundle was greater than the total number of patients admitted to ICU with a diagnosis of septic shock |
|                | The number of patients admitted to ICU with a diagnosis of septic shock and completed 6 h bundle was greater than the total number of patients admitted to ICU with a diagnosis of septic shock |
|                | The number of inpatients in ICU with DVT prophylaxis was greater than the total number of inpatients in ICU |
|                | The number of unplanned extubation patients was greater than the total number of extubation in ICU patients |
|                | The number of unplanned ICU transfer patients was greater than the total number of inpatients admitted to ICU |
|                | The total number of reintubation was 0 but the number of reintubation within 48 h was >0 |
The number of patients returning to ICU within 48 h after discharging from ICU was greater than the total number of patients discharging from ICU.

The number of cases of VAP in ICU was greater than the total sum of the days that each patient who was put on the invasive mechanical ventilation.

The number of cases of CRBSI in ICU was greater than the total sum of the days that each patient who had indwelling intravascular catheter.

The number of cases of CAUTI in ICU was greater than the total sum of the days that each patient who had an indwelling catheter.

The number of deaths in ICU was a negative value.

The number of cases had decimals.

CAUTI: Catheter-associated urinary tract infection; CRBSI: Catheter-related bloodstream infection; DVT: Deep vein thrombosis; ICU: Intensive care unit; VAP: Ventilator-associated pneumonia.

**Supplementary Table 2: Missing data for variables in the hospitals analyzed in the study.**

| Variables                                                                 | Hospitals | Missing number | Valid number | Proportion (%) |
|--------------------------------------------------------------------------|-----------|----------------|--------------|----------------|
| Proportion of ICU inpatients within total inpatients                    | 665       | 71             | 594          | 10.7           |
| Proportion of ICU bed occupancy within total inpatient bed occupancy    | 665       | 88             | 577          | 13.2           |
| Proportion of patients with APACHE II scores ≥15 within all ICU patients | 665       | 154            | 511          | 23.2           |
| 3-h SSC bundle completion rate                                           | 665       | 242            | 423          | 36.4           |
| 6-h SSC bundle completion rate                                           | 665       | 242            | 423          | 36.4           |
| Microbiology detection rate before antibiotics                           | 665       | 166            | 499          | 25.0           |
Proportion of DVT prophylaxis & 665 & 140 & 525 & 21.1
Unplanned extubation in the ICU & 665 & 159 & 506 & 23.9
Reintubation within 48 h after extubation & 665 & 166 & 499 & 25.0
Unplanned ICU transfer rate & 665 & 180 & 485 & 27.1
Readmission rate within 48 h after ICU discharge & 665 & 72 & 593 & 10.8
VAP morbidity in ICU & 665 & 89 & 576 & 13.4
CRBSI morbidity in ICU & 665 & 103 & 562 & 15.5
CAUTI morbidity in ICU & 665 & 95 & 570 & 14.3
Mortality rate & 665 & 120 & 545 & 18.0

Data were missing due to incomplete data in native datasets and illogical or entry errors identified in data cleaning.

CAUTI: Catheter-associated urinary tract infection; CRBSI: Catheter-related bloodstream infection; DVT: Deep vein thrombosis; ICU: Intensive care unit; SSC: Surviving sepsis campaign; VAP: Ventilator-associated pneumonia.

**Supplementary Table 3: Correlation between mortality and quality indicators.**

| Quality indicators                        | Mortality | Spearman correlation | P-value |
|-------------------------------------------|-----------|----------------------|---------|
| APACHE II score ≥15                       |           | 0.31017              | <0.0001 |
| 3-h SSC bundle compliance                 |           | 0.01617              | 0.7550  |
| Microbiology detection rate before antibiotics |       | 0.07293              | 0.1338  |
| Proportion of unplanned endotracheal extubations | | 0.09361              | 0.0502  |
| Unplanned transfer to ICU                 |           | 0.18887              | <0.0001 |
| VAP                                       |           | –0.04289             | 0.3454  |
| CRBSI                                     |           | 0.09679              | 0.0355  |

CRBSI: Catheter-related bloodstream infection; ICU: Intensive care unit; SSC: Surviving sepsis campaign; VAP: Ventilator-associated pneumonia.
Supplementary Figure 1: The relationship between GDP and ICU mortality and nosocomial infection. GDP: Gross domestic product; ICU: Intensive care unit.