# Evaluating Adherence to the 2021 Surviving Sepsis Campaign Guidelines for Sepsis and Septic Shock Management in Intensive Care Units: A Prospective Observational Study

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**Abstract:** This study evaluated adherence to the 2021 Surviving Sepsis Campaign (SSC) guidelines for managing sepsis and septic shock in a tertiary intensive care unit (ICU), aiming to identify deviations from recommended practices and their clinical implications. A prospective observational study was conducted over six months in the ICU of an academic tertiary-care hospital. Patients aged 50–80 years with sepsis or septic shock were enrolled (n=138). Adherence to 17 SSC 2021 recommendations was assessed using structured case report forms and electronic medical records, and clinical parameters, therapeutic interventions, and outcomes were analysed to determine adherence rates and areas of nonadherence. Adherence was high for foundational resuscitative measures, including early administration of intravenous crystalloids (100%), maintenance of mean arterial pressure (MAP) ≥ 65 mm Hg (100%), and comprehensive medication reconciliation (100%). In contrast, adherence to the recommendation against using the Quick Sequential Organ Failure Assessment as a sole screening tool was 0%. Adherence was suboptimal for low-molecular-weight heparin as the preferred agent for venous thromboembolism prophylaxis (57.1%) and for lung-protective ventilation in acute respiratory distress syndrome (75%). ICU mortality was 16.7%, and the 30-day readmission rate was 23.9%. While adherence to core resuscitative components of the SSC guidelines was robust, important gaps persisted in diagnostic screening practices, thromboprophylaxis choice, and ventilatory strategies, highlighting actionable targets for quality improvement.

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## Introduction

Sepsis and septic shock remain major causes of global morbidity and mortality. They arise from a dysregulated host response to infection that precipitates life-threatening organ dysfunction; in septic shock, profound circulatory and cellular-metabolic abnormalities necessitate vasopressors and are accompanied by elevated serum lactate (Liu et al., 2024). Globally, an estimated 48.9 million incident cases and 11 million deaths are attributed to sepsis each year – nearly 20% of all deaths (Rudd et al., 2020). Pathogenesis begins with activation of the innate immune system by pathogen- and damage-associated molecular signals, triggering systemic inflammation, endothelial injury, and subsequent immune suppression. This dysregulation drives multiorgan dysfunction and increases susceptibility to nosocomial infections (Jarczak et al., 2021).

Prompt recognition and early, bundle-based care are foundational. However, clinical features are nonspecific and overlap with other critical syndromes, contributing to delays – particularly among older adults and residents of long-term care facilities (Yoshikawa et al., 2019). The Sepsis-3 framework reconceptualised sepsis as infection complicated by organ dysfunction with increased mortality risk, aiming to improve diagnostic precision and reduce practice variability (Singer et al., 2016). Initial management centres on timely broad-spectrum antimicrobials, judicious intravenous fluids, vasopressors when indicated, and organ-supportive measures under evidence-based protocols such as the Surviving Sepsis Campaign (SSC). However, real-world implementation of SSC bundles remains uneven, with persistent gaps in time-to-antibiotics, fluid resuscitation volumes, and vasopressor practices (Dugar et al., 2020; Ranjit and Kissoon, 2021; Park et al., 2024). Even in well-resourced settings, adherence to key SSC elements is suboptimal, contributing to preventable morbidity and mortality (Levy et al., 2015).

Emerging approaches such as including biomarker-guided decision-making, individualised fluid strategies, and extracorporeal therapies show promise for improving early recognition and response, yet their uptake is limited by heterogeneous evidence, cost, and lack of standardised protocols (Kellum et al., 2016; Mehta et al., 2023; He et al., 2024). Against this backdrop, our prospective observational study aims to evaluate the clinical management of sepsis and septic shock in an intensive care unit, explicitly focusing on adherence to the 2021 SSC guidelines.

## Aims and Objectives

### Aim

To assess adherence with the 2021 Surviving Sepsis Campaign guidelines in treating sepsis and septic shock within intensive care unit (ICU) patients while pinpointing critical gaps in protocol adherence that impact patient outcomes.

### Specific objectives

1) To measure the degree of alignment with key 2021 SSC recommendations concerning hemodynamic interventions, antimicrobial regimens, supplementary therapies, and supportive care among ICU patients diagnosed with sepsis or septic shock.
2) To examine clinical and treatment profiles, including fluid resuscitation approaches, vasopressor administration, ventilatory strategies, corticosteroid use, and venous thromboembolism (VTE) prevention, in the study cohort.

## Methods

### Study design and setting

This prospective observational study was conducted over six months in a tertiary-care academic hospital's ICU equipped with advanced monitoring and therapeutic capabilities.

### Participants and eligibility

Patients aged 50–80 years admitted to the ICU with a clinical diagnosis of sepsis or septic shock were included. Restriction to 50–80 years reflects our ICU's local epidemiology: sepsis admissions. We initially screened using the quick Sequential Organ Failure Assessment (qSOFA) tool. We included if the diagnosis was confirmed by organ dysfunction consistent with the third international consensus definitions for sepsis and septic shock (Sepsis-3) and guideline-based clinical judgment.

Exclusion criteria were: age < 18 years, pregnancy or breastfeeding, advanced-stage organ dysfunction, receipt of palliative care, or incomplete medical records.

### Sampling and sample size

Purposive sampling was used to enrol consecutive eligible patients during the study period. Assuming an ICU census of 210 patients over six months, a 5% margin of error, and a 95% confidence level target, the minimum sample size is 138.

### Data collection and variables

Clinical and therapeutic data were collected prospectively using structured case report forms and

cross-verified with electronic medical records (EMRs). The following variables were recorded:

- Demographics: age, sex, and pre-existing comorbidities
- Clinical characteristics: qSOFA score, mean arterial pressure (MAP), blood glucose, and vital signs
- Therapeutic interventions: fluid resuscitation (type and volume), vasopressor use (agent and dose), antimicrobial therapy (agents, duration, and methicillin-resistant *Staphylococcus aureus* [MRSA] coverage), corticosteroid use (type and duration), and insulin administration
- Supportive care: mechanical ventilation, VTE prophylaxis, stress ulcer prophylaxis, and medication reconciliation
- Clinical outcomes: ICU length of stay, total hospital length of stay, duration of vasopressor support, achievement of MAP ≥ 65 mm Hg, complications, ICU mortality, and 30-day readmission

### Guideline-adherence assessment

Seventeen Surviving Sepsis Campaign 2021 recommendations were preselected for adherence assessment based on: (1) direct measurability from EMRs or bedside documentation; (2) established clinical relevance to ICU management and patient-centred outcomes; (3) clear operational definitions enabling binary (yes/no) assessment; and (4) support from peer-reviewed literature, with a priori justifications (Supplementary Table 1).

Selected domains included:

- Hemodynamic management: initial MAP target, fluid choice, vasopressor selection, and escalation
- Antimicrobial stewardship: empirical MRSA coverage and removal of intravascular devices
- Adjunctive therapies: corticosteroids for refractory shock; low tidal-volume ventilation for acute respiratory distress syndrome (ARDS)
- Supportive care: VTE prophylaxis and stress ulcer prevention
- Monitoring and transitions: blood-glucose thresholds for insulin initiation; medication reconciliation at ICU and hospital discharge; and discharge summary documentation

Each recommendation was translated into a measurable binary variable. Adherence was coded as present when the specified practice was documented during the ICU stay or a contraindication was recorded; otherwise, it was coded as non-adherent. Data definitions followed SSC 2021 language and were adapted to local documentation practices to balance feasibility and clinical relevance.

### Statistical analysis

Descriptive statistics summarised demographics, clinical characteristics, management strategies, and outcomes. Continuous variables were reported as means with standard deviations (SD) if the data were normally distributed; otherwise, medians and interquartile ranges were reported. Categorical variables as frequencies and percentages. All data were recorded in structured Excel spreadsheets and cross-validated against EMRs to ensure completeness and internal consistency.

### Ethical considerations

The Institutional Ethics Committee approved the study (VIPT/IEC/Date: 24/09/2024; No. 119). Written informed consent was obtained from all participants or their legally authorised representatives. Data confidentiality was maintained, and all procedures adhered to the Declaration of Helsinki.

**Table 1: Clinical parameters in sepsis and septic shock patients**

| Variable | Mean | SD |
|---|---|---|
| Age | 65.68 | 8.59 |
| qSOFA score | 2.33 | 0.85 |
| Vasopressor dose (mcg/kg/min) | 0.92 | 2.14 |
| Antibiotic duration (days) | 9.16 | 2.67 |
| Steroid duration (days) | 3.61 | 3.35 |
| Blood glucose (mg/dl) | 203.78 | 78.17 |
| Insulin dose (units) | 4.72 | 4.07 |
| ICU stay (days) | 16.04 | 8.64 |
| Hospital stay (days) | 25.53 | 9.56 |

qSOFA – quick Sequential Organ Failure Assessment; ICU – intensive care unit; SD – standard deviation

## Results

A total of 138 patients with sepsis or septic shock were enrolled over the study period. Descriptive statistics for continuous variables are summarised in Table 1. The mean age was 65.68 years (SD 8.59). The qSOFA score at presentation averaged 2.33 (SD 0.85). The mean ICU and hospital lengths of stay were 16.04 days (SD 8.64) and 25.53 days (SD 9.56), respectively. Mean blood glucose was elevated at 203.78 mg/dl (SD 78.17); insulin therapy was initiated when clinically indicated. The mean vasopressor dose was 0.92 µg/kg/min (SD 2.14). The median durations of antibiotic and corticosteroid therapy were 9.16 and 3.6 days, respectively.

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**Table 2: Clinical and treatment characteristics of sepsis and septic shock patients**

| Variable | Category* | n (%) |
|---|---|---|
| Gender | male | 72 (52.17%) |
| MAP | <65 mm Hg | 122 (88.40%) |
| Comorbidities | yes | 125 (90.58%) |
| Fluid type | crystalloid | 138 (100.0%) |
| | colloids | 16 (11.59%) |
| Vasopressin addition | yes | 75 (54.35%) |
| MRSA coverage | yes | 118 (85.51%) |
| Steroid use | yes | 79 (57.25%) |
| BMI category | normal | 55 (39.86%) |
| | overweight | 35 (25.36%) |
| | obese | 34 (24.64%) |
| | underweight | 14 (10.14%) |
| Fluid volume (ml/kg) | 30 | 132 (95.60%) |
| | 500 | 11 (7.97%) |
| | 25 | 6 (4.35%) |
| | 1000 | 5 (3.62%) |
| Vasopressor used | Norepinephrine | 111 (80.43%) |
| | Epinephrine | 35 (25.36%) |
| | none | 16 (11.59%) |
| | Dopamine | 11 (7.97%) |
| Antibiotic used | Linezolid | 13 (9.42%) |
| | Ceftriaxone | 20 (14.50%) |
| | Piperacillin-Tazobactam | 60 (43.48%) |
| | Vancomycin | 105 (76.08%) |
| | Meropenem | 45 (32.60%) |
| Steroid type | Hydrocortisone | 60 (43.48%) |
| | none | 59 (42.75%) |
| | Dexamethasone | 15 (10.87%) |
| | Methylprednisolone | 4 (2.90%) |
| Steroid dose (day doses) | none | 59 (42.75%) |
| | 200 mg/kg | 60 (43.48%) |
| | 6 mg | 15 (10.87%) |
| | 2 mg/kg | 4 (2.90%) |

*only "yes" and "higher frequency" responses are shown for dichotomous variables; MAP – mean arterial pressure; MRSA – methicillin-resistant *Staphylococcus aureus*; BMI – body mass index

Table 2 outlines the clinical and therapeutic characteristics of the cohort. Males comprised 52.2% of the cohort. Most patients (88.4%) presented with MAP < 65 mm Hg. Comorbidities were present in 90.6% of patients. Crystalloid resuscitation was universal, and vasopressin was added to catecholamine vasopressors in 54.3% of cases. Among antimicrobials, vancomycin (76.1%) and piperacillin-tazobactam (43.5%) were most frequently administered. Corticosteroids, predominantly hydrocortisone, were initiated in 57.3% of patients.

**Table 3: Venous thromboembolism, prophylaxis, and medication safety practices in sepsis and septic shock patients**

| Variable | Category* | n (%) |
|---|---|---|
| Intravascular access devices used | yes | 80 (57.98%) |
| GI bleeding risk | yes | 39 (28.26%) |
| Stress ulcer prophylaxis | yes | 67 (48.55%) |
| VTE prophylaxis | yes | 91 (65.94%) |
| Medication reconciliation ICU | yes | 116 (84.05%) |
| Medication reconciliation hospital | yes | 138 (100.0%) |
| Medication discrepancies | yes | 29 (21.01%) |
| Discharge summary provided | yes | 123 (89.13%) |
| Mortality | deceased | 23 (16.67%) |
| Readmission (30 days) | yes | 33 (23.91%) |
| Complications | yes | 63 (45.65%) |
| Prophylaxis type | PPI | 43 (31.15%) |
| | H2 blockers | 24 (17.39%) |
| | none | 71 (51.45%) |
| VTE type | unfractionated heparin | 39 (28.26%) |
| | LMWH | 52 (37.68%) |
| | none | 47 (34.06%) |
| VTE contraindications | none | 91 (65.94%) |
| | bleeding risk | 40 (28.99%) |
| | recent surgery | 7 (5.07%) |
| Glucose monitoring frequency | every 6 hours | 56 (40.58%) |
| | every 2 hours | 48 (34.78%) |
| | every 4 hours | 34 (24.64%) |

*for dichotomous variables, only the category with the higher frequency (e.g., "yes" or "deceased") is shown; GI – gastro intestinal; ICU – intensive care unit; PPI – proton pump inhibitors; VTE – venous thromboembolism; LMWH – low-molecular-weight heparin; H2 – histamine 2

Medication safety and prophylactic practices are summarized in Table 3. Intravascular access devices were used in 58.0% of patients. Stress-ulcer prophylaxis and VTE prophylaxis were implemented in 48.6 and 65.9% of cases, respectively. When pharmacologic VTE prophylaxis was used, low-molecular-weight heparin (LMWH) was more common than unfractionated heparin (UFH). Medication reconciliation was documented for 84.1% of patients during the ICU stay and 100% at hospital discharge. Discharge summaries explicitly noting

**Table 4: Adherence with 2021 Surviving Sepsis Campaign recommendations**

| S. No. | Recommendation* | Adherence – n/N (%) |
|---|---|---|
| 1 | Avoid qSOFA as sole screen | 0/138 (0.0%) |
| 2 | Target MAP ≥ 65 mm Hg | 122/122 (100.0%) |
| 3 | Empiric MRSA coverage | 118/138 (85.5%) |
| 4 | Remove suspect IV access | 60/80 (75.0%) |
| 5 | Use crystalloids first | 138/138 (100.0%) |
| 6 | Albumin after large crystalloids | 16/16 (100.0%) |
| 7 | Avoid starches | 138/138 (100.0%) |
| 8 | Norepinephrine first-line | 111/122 (91.0%) |
| 9 | Add vasopressin as needed | 97/111 (87.4%) |
| 10 | Low tidal volume in ARDS | 36/48 (75.0%) |
| 11 | IV corticosteroids in shock | 79/100 (79.0%) |
| 12 | Stress ulcer prophylaxis | 39/39 (100.0%) |
| 13 | VTE prophylaxis unless contraindicated | 91/91 (100.0%) |
| 14 | Prefer LMWH over UFH | 52/91 (57.1%) |
| 15 | Start insulin ≥ 180 mg/dl | 78/78 (100.0%) |
| 16 | Reconcile ICU + discharge meds | 138/138 (100.0%) |
| 17 | Document sepsis in discharge summary | 123/138 (89.13%) |

*recommendations abbreviated for brevity. Refer to supplementary material for full guideline descriptions; n – number of participants who were compliant with the recommendation; N – total number of participants for whom that recommendation was applicable; qSOFA – quick Sequential Organ Failure Assessment; MAP – mean arterial pressure; MRSA – methicillin-resistant *Staphylococcus aureus*; IV – intravenous; ARDS – Acute Respiratory Distress Syndrome; LMWH – low-molecular-weight heparin; UFH – unfractionated heparin; ICU – intensive care unit; S.No. – serial number

sepsis-related events were provided in 89.1% of cases. ICU mortality was 16.7%, and the 30-day readmission rate was 23.9%.

Adherence with the 2021 Surviving Sepsis Campaign guidelines is detailed in Table 4. Full adherence (100%) was achieved for early crystalloid administration, avoidance of starches, targeting MAP ≥ 65 mm Hg, applying insulin initiation thresholds as recommended, and completing medication reconciliation. Adherence varied for empiric methicillin-resistant *Staphylococcus aureus* (MRSA) coverage, early addition of vasopressin, low-tidal-volume ventilation, and corticosteroid use in shock. Among patients eligible for pharmacologic VTE prophylaxis, LMWH % preferred over UFH in 57.1%.

## Discussion

In this evaluation of adherence to the 2021 SSC guidelines, compliance was high for core resuscitative measures, including early administration of crystalloids, maintenance of MAP ≥ 65 mm Hg, appropriate insulin initiation thresholds, avoidance of starch-based fluids, and thorough medication reconciliation. In contrast, several domains demonstrated suboptimal adoption. qSOFA was used as the sole screening tool in all cases, contrary to current guidance discouraging its standalone use. Guideline-concordant VTE prophylaxis favoured low-molecular-weight heparin over unfractionated heparin in only 57.1% of eligible patients. Implementation of lung-protective ventilation (LPV) in acute respiratory distress syndrome and corticosteroid therapy for vasopressor-dependent septic shock occurred in 75 and 79% of applicable cases, respectively. The observed ICU mortality of 16.7% and 30-day readmission rate of 23.9% provide clinical context and suggest that variability in diagnostic, prophylactic, and ventilatory practices may influence outcomes beyond initial hemodynamic management.

qSOFA, designed as a pragmatic bedside risk tool, continues to be used for initial screening, likely due to its simplicity and lack of laboratory requirements. However, the 2021 SSC discourages its use as a sole screening strategy because of limited sensitivity for early sepsis detection. Evidence indicates that only 24% of infected patients have qSOFA ≥ 2 (Oczkowski et al., 2022; Prescott and Ostermann, 2023), and while specificity is high (87–98%), sensitivity is low (26.9–53%) (Luo et al., 2019; Jamshed et al., 2023; Qiu et al., 2023). By comparison, SIRS maximises sensitivity (up to 98%) at the cost of specificity, whereas NEWS offers a more balanced diagnostic profile (Daga et al., 2021). Although requiring laboratory data, SOFA remains the strongest predictor of in-hospital mortality (sensitivity 89%, specificity 69%) (Qiu et al., 2023). Reliance on qSOFA alone risks delayed intervention; for example, nearly one-third of patients who progressed to pneumococcal septic shock were missed (Rein et al., 2020). Accordingly, qSOFA's role is best viewed as prognostic rather than diagnostic: patients with qSOFA ≥ 2 have substantially higher odds of 28-day mortality (OR [odds ratio] 6.9; 95% CI [confidence interval] 4.6–10.3) (Jamshed et al., 2023). A multimodal approach – combining clinical judgment with lactate, SOFA-based assessment, and early biomarkers – should replace qSOFA-only screening (Daga et al., 2021; Prescott and Ostermann, 2023).

LMWH is recommended by SSC and CHEST as the preferred pharmacologic prophylaxis in most critically ill patients due to predictable pharmacokinetics, lower risk of heparin-induced thrombocytopenia, minimal monitoring, and favourable cost-effectiveness (Wadhera and Piazza, 2014; Guarino et al., 2023; Patel and Varacallo, 2025). Meta-analytic data show

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reductions in pulmonary embolism and ICU length of stay, with fewer adverse events (Wadhera and Piazza, 2014). Despite these advantages and evidence supporting safety at prophylactic doses in moderate renal impairment (Crowther and Lim, 2015), LMWH utilisation remained modest (57.1%). Persistent concerns about bleeding, misconceptions regarding renal clearance, and acquisition-cost-driven protocols may explain the shortfall, even though downstream savings from fewer complications and readmissions are well documented (Wadhera and Piazza, 2014). Given the prothrombotic milieu of sepsis, protocolised LMWH use informed by validated risk models (Padua, IMPROVE) could reduce preventable events and resource use (Skeik and Westergard, 2020; Clapham and Roberts, 2023).

Robust evidence supports LPV (tidal volume ~ 6 ml/kg predicted body weight with plateau pressure targets) as a mortality-reducing strategy in ARDS; ARDSNet data demonstrated a ~ 9% absolute mortality reduction (Alhazzani et al., 2020). Nevertheless, real-world adherence remains inconsistent – reported as low as 13% under strict criteria – due to delayed ARDS recognition, default ventilator settings, and inter-provider variability (Ward et al., 2016). In this cohort, LPV use in 75% of eligible cases represents progress but leaves a sizable gap. Structured diagnostic pathways, ventilator order sets with default LPV parameters, and targeted education have been shown to improve fidelity (Knighton et al., 2020; Arrivé et al., 2021).

The SSC recommends 200 mg/day IV hydrocortisone in septic shock refractory to fluids and vasopressors (Garner et al., 2025). Randomised trials demonstrate reductions in time to shock resolution and duration of mechanical ventilation (Venkatesh et al., 2018) and, when combined with fludrocortisone, lower 90-day mortality and more vasopressor-free days (Annane et al., 2018). Implementation in 79% of eligible cases indicates reasonable uptake, yet gaps persist – often related to diagnostic uncertainty, concerns about hyperglycemia, immunosuppression, and secondary infection (Yerke et al., 2020). Evidence suggests benefits with early initiation (ideally within 3 hours of shock recognition) and that 200 mg/day, whether as divided boluses or continuous infusion, yields comparable efficacy (Alsulami et al., 2023). Algorithmic decision support linked to vasopressor dosing and lactate kinetics may standardise timing and monitoring.

Despite advances, case-fatality in septic shock remains 30–40% and correlates with poorer adherence to guideline bundles (Via et al., 2024). Observational analyses associate bundle completion, particularly the one-hour bundle, with reduced 28-day mortality (adjusted OR 0.44; 95% CI 0.25–0.78), and timely fluid resuscitation (>30 ml/kg within 3 hours) with lower in-hospital mortality (Piehl et al., 2025). The ICU mortality (16.7%) and 30-day readmission (23.9%) observed here are broadly consistent with prior registries (Walkey et al., 2018). Given that sepsis accounts for 12.2% of 30-day readmissions (Prescott and Angus, 2018), structured discharge planning, early follow-up, and VTE prophylaxis continuation where indicated are rational post-acute priorities.

Findings highlight concrete targets for quality improvement: (i) replace qSOFA-only screening with multimodal early-recognition pathways anchored by lactate and SOFA-based assessment; (ii) standardize LMWH-first VTE prophylaxis with embedded renal-dose and bleeding-risk safeguards; (iii) hard-wire LPV via default ventilator order sets and bedside prompts; and (iv) operationalize steroid initiation algorithms for vasopressor-dependent shock with predefined monitoring. Real-time electronic health record (EHR) prompts, multidisciplinary education, and audit-and-feedback cycles can help close these gaps.

This single-center, purposive-sample study lacked a control group, limiting causal inference and generalizability. EMR-based adherence measurement captured 17 SSC 2021 recommendations, potentially omitting relevant practices. Provider-level variables and precise intervention timing were not adjusted for and may confound associations between adherence and outcomes.

## Conclusion

This study identifies persistent shortfalls in adherence to the 2021 Surviving Sepsis Campaign guidelines, most notably in early diagnostic screening, venous thromboembolism prophylaxis, lung-protective ventilation, and corticosteroid administration. Despite robust evidence and explicit recommendations, practice patterns remain inconsistent, indicating a need for system-level recalibration. Exclusive reliance on quick Sequential Organ Failure Assessment, underuse of low-molecular-weight heparin, and inconsistent delivery of LPV represent missed opportunities to optimise sepsis care. Future work should evaluate how bundle adherence affects long-term outcomes, including functional recovery and post-discharge morbidity. Multicenter, prospective studies with real-time data feedback and provider-level analyses are warranted to delineate persistent barriers. Integrating digital tools, audit-feedback cycles, and targeted education will be essential to improving adherence and, ultimately, clinical outcomes.

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