

IMPROVING EARLY SEPSIS MANAGEMENT THROUGH IMPLEMENTATION OF THE SEPSIS SIX BUNDLE: A CLINICAL AUDIT, QUALITY IMPROVEMENT INTERVENTION, AND RE-AUDIT

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DOI: <http://doi.org/10.5281/zenodo.22024972>

Received 2 Feb 2026	Accepted 15 March 2026	Published 31 March 2026
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ABSTRACT

Background: Sepsis is a time-critical clinical condition in which delays in recognition and initiation of appropriate treatment can contribute to adverse outcomes. The Sepsis Six bundle provides a simple framework for delivering key diagnostic and therapeutic interventions during the first hour of sepsis management. However, translating recommended sepsis care into consistent bedside practice remains challenging, particularly in busy and resource-constrained healthcare settings. This clinical audit and quality improvement project was undertaken to assess compliance with the Sepsis Six bundle in a tertiary-care medical unit and to determine whether a locally feasible quality improvement intervention could improve the timeliness and completeness of early sepsis management.

Methods: A two-cycle clinical audit and quality improvement project was conducted in the Medical B Unit of Ayub Teaching Hospital, Abbottabad, using a Plan–Do–Study–Act (PDSA) approach. The baseline audit was conducted from 1st September 2025 to 30th October 2025, followed by a multifaceted quality improvement intervention and a re-audit from 20th November 2025 to 20th January 2026. Adult patients aged ≥18 years with suspected or clinically documented sepsis and sufficient documentation for assessment of initial management were included. Compliance with the six components of the Sepsis Six bundle—serum lactate measurement, blood culture collection, appropriate intravenous antibiotics, intravenous fluids when clinically indicated, oxygen assessment/administration when indicated, and urine-output monitoring—was assessed within one hour of recognition of suspected sepsis. The predefined audit standard was ≥90% compliance with each applicable component and with the complete bundle. The intervention included staff education, introduction of a standardized Sepsis Six checklist, reinforcement during ward rounds and handovers, improved documentation of recognition and intervention times, and regular feedback to the clinical team.

Results: The baseline audit included 84 patients, while the re-audit included 88 patients. Overall compliance with completion of all applicable Sepsis Six components within one hour increased substantially from 21.4% at baseline to 64.8% after the intervention, representing an absolute improvement of 43.4 percentage points. Improvement was observed across all six individual components.

Timely serum lactate measurement increased from 41.7% to 79.5%, appropriate blood culture collection from 38.1% to 77.3%, intravenous antibiotic administration within one hour from 57.1% to 86.4%, intravenous fluid administration when indicated from 65.7% to 82.7%, oxygen assessment/administration when indicated from 81.0% to 91.5%, and urine-output monitoring from 46.4% to 83.0%. Oxygen assessment and administration when clinically indicated was the only individual component to achieve the predefined $\geq 90\%$ audit standard. The median time from recognition of suspected sepsis to lactate sampling decreased from 74 to 42 minutes, blood culture collection from 81 to 45 minutes, antibiotic administration from 68 to 39 minutes, intravenous fluid initiation from 54 to 37 minutes, oxygen administration from 31 to 24 minutes, and urine-output monitoring from 96 to 49 minutes. In-hospital mortality decreased from 19.0% to 14.8%, while median hospital stay decreased from 8 to 7 days; however, these clinical outcome changes were interpreted cautiously because the before-and-after audit design could not establish a causal relationship between improved bundle compliance and patient outcomes.

Conclusion: This clinical audit identified substantial gaps in the timely delivery of early sepsis care in the Medical B Unit of Ayub Teaching Hospital, Abbottabad. A locally adapted, low-cost and multidisciplinary PDSA-based intervention was associated with marked improvement in both the completeness and timeliness of Sepsis Six delivery. Although the predefined overall compliance target of $\geq 90\%$ was not achieved, the improvement from 21.4% to 64.8% demonstrates that structured education, standardized documentation, bedside checklists, team reinforcement and audit feedback can meaningfully improve early sepsis management within existing hospital resources. Further PDSA cycles, continued audit and feedback, and improved coordination between medical, nursing and laboratory teams are required to sustain these gains and further close the remaining performance gap.

Keywords: Sepsis; Sepsis Six; Clinical Audit; Quality Improvement; PDSA; Early Sepsis Management; Tertiary Care Hospital.

Introduction

Sepsis is a life-threatening clinical syndrome resulting from a dysregulated host response to infection leading to organ dysfunction. It remains one of the major causes of morbidity and mortality among hospitalized patients worldwide and continues to impose a substantial burden on healthcare systems. The World Health Organization (WHO) estimates that approximately 48.9 million cases of sepsis and 11 million sepsis-related deaths occurred globally in 2017, accounting for nearly one-fifth of all deaths worldwide. The burden is particularly high in low- and middle-income countries (LMICs), where delayed presentation, limited healthcare resources, inadequate infection control, antimicrobial resistance and gaps in early recognition and treatment contribute to poor outcomes.^{1,2} The clinical course of sepsis can deteriorate rapidly, with progression from infection-associated organ dysfunction to septic shock and multiple organ failure. Therefore, early recognition followed by prompt initiation of appropriate treatment is a

fundamental component of sepsis management. Current international recommendations emphasize rapid assessment of patients with suspected sepsis, early measurement of lactate where appropriate, obtaining microbiological cultures when this can be done without delaying treatment, timely administration of antimicrobial therapy, appropriate intravenous fluid resuscitation and early escalation of cardiovascular support in patients who remain hypotensive.³ The emphasis has increasingly shifted from isolated interventions to coordinated, time-sensitive care pathways that facilitate simultaneous recognition, investigation and treatment. The Sepsis Six bundle was developed as a simple bedside framework to facilitate delivery of key early interventions in patients with suspected sepsis. It consists of three diagnostic and three therapeutic components: assessment of oxygenation and administration of oxygen when indicated, obtaining blood cultures, measuring serum lactate, administering intravenous antibiotics, initiating intravenous fluid resuscitation when indicated,

and monitoring urine output. The principal advantage of such a bundle is not that each component is novel, but that important interventions are brought together into a standardized sequence that can be initiated promptly by the clinical team. Earlier studies evaluating Sepsis Six implementation have demonstrated that structured bundle-based care can improve compliance with recommended interventions and may be associated with improved clinical outcomes.^{4,5} Despite the availability of international guidelines, translating recommendations into routine bedside practice remains challenging. Delays may occur at several stages of care, including recognition of sepsis, documentation of vital signs and severity, obtaining lactate and blood cultures, establishing intravenous access, prescribing and administering antibiotics, initiating appropriate fluid therapy, and monitoring urine output. These problems are particularly relevant in busy medical wards and emergency areas where patient volume is high and clinical care depends on coordination between doctors, nurses, laboratory personnel and other hospital services. Importantly, failure to complete one component of a sepsis pathway may result in delays in other components, making a standardized and easily understood approach particularly useful in routine clinical practice. Evidence from quality improvement initiatives suggests that improving sepsis care requires more than simply disseminating guidelines. Multifaceted interventions involving staff education, standardized protocols, bedside prompts, improved communication, audit and feedback, and repeated monitoring have been shown to improve adherence to sepsis bundles. A multicentre quality improvement programme involving non-intensive-care patients demonstrated a significant increase in compliance with the Sepsis Six following implementation of educational and organizational interventions, with the intervention period also associated with lower hospital mortality.⁶ Similarly, quality improvement programmes using structured multidisciplinary approaches have demonstrated that sepsis bundle compliance can be improved through systematic changes in clinical processes

rather than relying solely on individual clinician awareness.⁷

The challenges are even more important in resource-constrained healthcare settings. In LMICs, implementation of sepsis care pathways has to take into account limitations in laboratory availability, staffing, bed capacity, monitoring facilities, antimicrobial availability and access to critical care. Recent literature has emphasized that improving sepsis outcomes in such settings should focus on practical, affordable and context-specific interventions rather than simply adopting resource-intensive models from high-income healthcare systems.⁸ Pakistan, being a LMIC, carries a substantial burden of sepsis, while published local data remain comparatively limited. A recent review of sepsis in Pakistan highlighted delayed access to healthcare, predominance of respiratory and urinary sources of infection, a high contribution of Gram-negative organisms and poor adherence to recommended sepsis management practices. The authors emphasized the need for simple, cost-effective and context-appropriate strategies to improve early recognition and management of sepsis.⁹

In a large tertiary-care hospital such as Ayub Teaching Hospital, Abbottabad, patients with suspected or established sepsis are managed across the emergency department, medical wards, high-dependency areas and intensive care facilities. The Medicine Unit receives a large number of acutely ill patients with infections of varying severity, and the initial management of sepsis frequently involves multiple members of the healthcare team. In this setting, delays or inconsistencies in completing basic early interventions may occur despite appropriate clinical knowledge among healthcare professionals. A locally adapted Sepsis Six pathway therefore has the potential to provide a practical framework for standardizing the initial management of patients with suspected sepsis without requiring major additional resources. Clinical audit provides an appropriate method for identifying such gaps between recommended standards and actual clinical practice. A baseline audit can quantify compliance with individual components of early sepsis management and identify specific areas requiring improvement. This can then be followed by a targeted quality

improvement intervention consisting of measures such as staff education, dissemination of a standardized Sepsis Six checklist, bedside reminders, improved documentation and regular feedback to the clinical team. Re-audit after implementation allows assessment of whether these interventions have translated into measurable improvement in clinical practice. Previous audit and re-audit work involving Sepsis Six has demonstrated that structured implementation and promotion of teamwork can result in substantial improvements in adherence to recommended sepsis care.¹⁰

The present clinical audit was therefore designed to assess the baseline level of compliance with early sepsis management according to the Sepsis Six bundle in adult patients presenting to the Medicine Unit of Ayub Teaching Hospital, Abbottabad. A quality improvement intervention was subsequently implemented with the aim of addressing identified deficiencies and improving timely delivery of the bundle. A re-audit was then performed to determine whether compliance had improved following the intervention. By focusing on simple, measurable and clinically relevant processes of care, this audit aims to identify modifiable gaps in early sepsis management and establish a sustainable approach for improving the quality and consistency of sepsis care within the local hospital setting.

Objectives

Primary Objective

- To assess and improve compliance with the Sepsis Six bundle within the first hour of recognition of suspected sepsis among adult patients managed in the Medicine Unit of Ayub Teaching Hospital, Abbottabad, through a clinical audit, targeted quality improvement intervention and subsequent re-audit.

Secondary Objectives

- To determine the baseline compliance with each individual component of the Sepsis Six bundle, namely:
 - measurement of serum lactate,
 - obtaining blood cultures before antibiotic administration where feasible,

- administration of appropriate intravenous antibiotics,
- administration of intravenous fluids when clinically indicated,
- assessment and provision of oxygen/respiratory support when indicated, and
- Monitoring of urine output.
- To identify the major gaps and practical barriers contributing to incomplete or delayed delivery of the Sepsis Six bundle in the Medicine Unit.
- To implement a locally feasible quality improvement intervention based on the deficiencies identified during the baseline audit, including structured staff education, reinforcement of the Sepsis Six protocol, standardized documentation/checklist use and feedback to the clinical team.
- To compare compliance with the individual components and the overall Sepsis Six bundle before and after implementation of the quality improvement intervention.
- To assess whether the quality improvement intervention results in improvement in the timely delivery of key early sepsis interventions, particularly intravenous antibiotic administration, blood culture collection, lactate measurement and appropriate fluid resuscitation.
- To assess selected clinical outcomes before and after the intervention, including in-hospital mortality, escalation to intensive care/high-dependency care and hospital length of stay, where adequate documentation is available.
- To identify areas requiring further improvement and develop recommendations for sustaining and integrating timely Sepsis Six-based care into routine clinical practice in the Medicine Unit of Ayub Teaching Hospital, Abbottabad.

Materials and Methods

Study Design and Setting

This was a **clinical audit and quality improvement project** conducted in the Medical B Unit of Ayub Teaching Hospital, Abbottabad, a tertiary-care teaching hospital in Khyber Pakhtunkhwa, Pakistan. The project was designed as a two-cycle clinical audit consisting of a **baseline audit followed by a quality improvement intervention and subsequent re-audit**. The

methodology was based on the Plan-Do-Study-Act (PDSA) quality improvement framework.

The project focused on the early management of adult patients with suspected sepsis admitted to or managed by the Medical B Unit. The Sepsis Six bundle was used as the practical framework for assessing the timeliness and completeness of initial sepsis management. The six components assessed were measurement of serum lactate, obtaining blood cultures, administration of appropriate intravenous antibiotics, administration of intravenous fluids when clinically indicated, assessment and administration of oxygen when indicated, and monitoring of urine output. The choice of the Sepsis Six was based on its simple bedside structure and its emphasis on delivering key diagnostic and therapeutic interventions during the initial hour of sepsis management.^{1,2}

Audit Period

The first clinical audit cycle was conducted from **1 September 2025 to 30 October 2025**. The findings from this baseline audit were reviewed to identify deficiencies in compliance with the Sepsis Six bundle and to determine areas that could be addressed through a locally feasible quality improvement intervention. Following implementation of the intervention, the second audit cycle (re-audit) was conducted from **20 November 2025 to 20th January 2026**. The two audit periods were separated by an intervention period during which the identified deficiencies were addressed through the PDSA approach.

Audit Population

The audit included **adult patients with suspected sepsis** who were assessed and managed in the Medical B Unit during the respective audit periods and who fulfilled the predefined criteria for inclusion.

Patients were identified from admission records, ward records, clinical notes and relevant laboratory documentation. For each eligible patient, the time at which sepsis was first clinically recognized or documented by the treating medical

team was taken as the reference point for assessing the timeliness of the Sepsis Six interventions.

Inclusion Criteria

Patients were eligible for inclusion if they:

- were 18 years of age or older;
- were admitted to or managed by the Medical B Unit during the audit period;
- had suspected or clinically documented sepsis at the time of initial assessment; and
- Had sufficient clinical documentation to allow assessment of at least the major components of the initial sepsis management pathway.

Exclusion Criteria

Patients were excluded if they:

- were younger than 18 years;
- had no clinical suspicion of sepsis during the initial assessment;
- were transferred to another unit before initial assessment and documentation of sepsis management could be completed;
- had incomplete records that did not allow assessment of the timing of initial sepsis management; or
- Had a documented treatment limitation or clinical circumstance in which a particular intervention was considered inappropriate.

Patients were not considered non-compliant for interventions that were **not clinically indicated**. For example, oxygen therapy and intravenous fluid administration were assessed according to the patient's clinical condition and treating team's documentation rather than assuming that these interventions were required in every patient.

Audit Standard

An explicit audit standard was established before analysis of the baseline audit findings. The target was based on the principle that the Sepsis Six interventions should be initiated promptly after recognition of suspected sepsis and on published descriptions of the bundle as a first-hour intervention^{1,2}. The audit standard was set at **≥90% compliance** with each applicable component of the Sepsis Six within the first hour of recognition of suspected sepsis.

The individual standards were defined as follows:

Sepsis Six component	Audit standard
Serum lactate measured	≥90% within 1 hour
Blood cultures obtained before antibiotics, where feasible	≥90% within 1 hour
Appropriate IV antibiotics administered	≥90% within 1 hour
IV fluids administered when clinically indicated	≥90% within 1 hour
Oxygen assessed and administered when clinically indicated	≥90% within 1 hour
Urine output monitoring initiated	≥90% within 1 hour
Overall Sepsis Six bundle compliance	≥90%

For the purposes of the audit, **overall bundle compliance** was defined as completion of all six components that were applicable to the individual patient within the first hour of sepsis recognition. Where a component was clinically not indicated, this was documented as “**not applicable**” and was excluded from the denominator for that individual component. This approach was adopted to avoid falsely lowering compliance by counting clinically inappropriate interventions as failures of care.

Data Collection

A structured audit proforma was developed for collection of patient and process-of-care information. Data were collected from the patient's medical notes, nursing documentation, medication administration records, laboratory reports, observation charts and fluid balance records.

The following variables were recorded:

- age and sex;
- date and time of recognition of suspected sepsis;
- suspected source of infection;
- relevant presenting clinical features;
- serum lactate measurement and time of sampling;
- blood culture collection and timing in relation to antibiotics;
- antibiotic prescription and actual time of administration;
- intravenous fluid administration and timing;
- oxygen assessment and administration where indicated;

- urine output monitoring;
- completion of the individual Sepsis Six components within one hour;
- overall Sepsis Six bundle compliance;
- need for escalation to high-dependency/intensive care;
- hospital outcome, including in-hospital mortality where available; and
- duration of hospital stay where adequately documented.

The **actual time of administration or performance of an intervention**, rather than merely its prescription or documentation in the medical notes, was considered whenever this information was available. This distinction was particularly important for antibiotics, intravenous fluids and oxygen therapy.

Definition of Timely Sepsis Six Delivery

The one-hour period was calculated from the documented time of **recognition of suspected sepsis** by the treating team. An intervention was considered timely if it was completed within 60 minutes of this reference time.

For blood cultures, collection before administration of antibiotics was considered appropriate where this could be achieved without causing clinically significant delay in antimicrobial treatment. This was consistent with the principle that microbiological samples should be obtained before antimicrobial therapy when feasible, while treatment should not be unnecessarily delayed.³

PDSA Quality Improvement Methodology

The quality improvement intervention was conducted using a **Plan-Do-Study-Act (PDSA)**

cycle. The PDSA framework was selected because it allowed the baseline deficiencies identified during the first audit cycle to be translated into practical changes in the local clinical workflow and subsequently assessed during re-audit.

Plan

The baseline audit results were reviewed by the audit team to identify the Sepsis Six components with the lowest compliance and the practical reasons for delayed or incomplete management. Particular attention was given to delays in recognition, documentation, blood culture collection, lactate measurement, antibiotic administration, fluid resuscitation and urine output monitoring.

Based on the identified deficiencies, a locally feasible intervention was planned with the aim of improving awareness, standardizing the initial approach to suspected sepsis and making the required interventions easier to initiate and document.

Do

The intervention consisted of a **multifaceted educational and process-based approach**. This included:

- brief educational sessions for doctors and nursing staff regarding recognition of suspected sepsis and the Sepsis Six bundle;
- reinforcement of the importance of completing the bundle within the first hour;
- dissemination of a simple Sepsis Six checklist/proforma for bedside use;
- emphasis on recording the time of sepsis recognition and the time at which each intervention was performed;
- reinforcement of obtaining blood cultures before antibiotics whenever feasible without delaying treatment;
- reinforcement of early administration of appropriate empirical intravenous antibiotics;
- reinforcement of appropriate intravenous fluid administration and reassessment according to the patient's clinical condition;
- reinforcement of urine output monitoring and accurate fluid balance documentation;

- use of verbal reminders during clinical handovers and ward rounds where appropriate; and

○ Feedback to the treating team regarding deficiencies identified during the baseline audit. The intervention was designed to be practical within the existing resources of the Medical B Unit and did not depend on the introduction of expensive equipment or additional specialist staff.

Study

Following implementation of the intervention, compliance was assessed during the second audit cycle from **20 November 2025 to 20 January 2026** using the same audit criteria and definitions applied during the baseline cycle.

The baseline and post-intervention groups were compared for:

- compliance with each individual Sepsis Six component;
- proportion of patients receiving all applicable components of the bundle within one hour;
- compliance with timely intravenous antibiotic administration;
- compliance with blood culture collection before antibiotics where feasible;
- compliance with lactate measurement;
- compliance with appropriate intravenous fluid administration;
- compliance with oxygen assessment/administration where indicated; and
- Compliance with urine output monitoring.

Selected clinical outcomes, including escalation of care, hospital length of stay and in-hospital mortality, were also compared descriptively between the two audit cycles where sufficient data were available.

Act

The findings of the re-audit were reviewed to determine whether the intervention resulted in meaningful improvement in compliance with the predefined audit standard. Components that remained below the desired standard were identified as targets for further improvement.

Where improvement was demonstrated but the predefined $\geq 90\%$ standard was not achieved,

further PDSA cycles were considered necessary to consolidate the changes and address remaining barriers. Successful elements of the intervention were intended to be incorporated into routine clinical practice in the Medical B Unit through continued use of the Sepsis Six checklist, staff reinforcement and periodic monitoring of compliance.

Outcome Measures

The **primary process outcome** was the change in overall compliance with the Sepsis Six bundle between the baseline audit and the re-audit. Secondary process outcomes included the change in compliance with each individual Sepsis Six component and the proportion of patients receiving key interventions within the first hour, particularly intravenous antibiotics, blood cultures and lactate measurement. Secondary clinical outcomes included **in-hospital mortality, escalation to intensive care/high-dependency care and hospital length of stay**, where reliable documentation was available. These outcomes were considered supportive clinical measures and were not interpreted as direct evidence of causation by the quality improvement intervention.

Data Analysis

Data from both audit cycles were entered into a structured database and analyzed using descriptive statistics. Continuous variables were summarized using mean and standard deviation or median and interquartile range, depending on the distribution of the data. Categorical variables were presented as frequencies and percentages. Compliance with each Sepsis Six component was calculated as:

Compliance (%) = Number of eligible patients receiving the intervention within 1 hour / Total number of eligible patients × 100

Overall Sepsis Six compliance was calculated separately based on completion of all applicable bundle components within one hour.

The baseline and re-audit compliance percentages were compared to determine the absolute improvement following the quality improvement intervention. Where appropriate, categorical variables were compared using the chi-square test or Fisher's exact test, while continuous variables were compared using an appropriate statistical test according to data distribution.

The main emphasis of the analysis was on **improvement in clinical practice and achievement of the predefined audit standard**, rather than establishing a causal relationship between bundle compliance and patient outcomes.

Ethical Considerations and Confidentiality

As this project was conducted as a clinical audit and quality improvement activity aimed at assessing and improving routine clinical practice, patient management was not altered solely for the purposes of data collection. The audit was conducted in accordance with institutional requirements and the principles of confidentiality and responsible use of patient information.

Patient identifiers were not included in the analysis dataset. Information obtained from clinical records was used only for the purpose of assessing compliance with the predefined audit criteria and evaluating the effect of the quality improvement intervention. Results were reported in aggregate form without identifying individual patients or healthcare workers.

RESULTS

Table 1. Demographic characteristics of patients included in the two audit cycles

Characteristic	Baseline audit (n=84)	Re-audit (n=88)
Age, mean ± SD (years)	56.8 ± 17.4	55.9 ± 16.8
Age ≥65 years	29 (34.5%)	28 (31.8%)

Characteristic	Baseline audit (n=84)	Re-audit (n=88)
Male	48 (57.1%)	51 (58.0%)
Female	36 (42.9%)	37 (42.0%)
Rural residence	51 (60.7%)	52 (59.1%)
Urban residence	33 (39.3%)	36 (40.9%)

The demographic profile was broadly comparable between the two audit cycles, reducing concern that a major difference in age or sex distribution explained the observed improvement.

Table 2. Common comorbidities among patients with suspected sepsis

Comorbidity	Baseline audit n (%)	Re-audit n (%)
Diabetes mellitus	31 (36.9%)	34 (38.6%)
Hypertension	29 (34.5%)	31 (35.2%)
Chronic kidney disease	14 (16.7%)	15 (17.0%)
Ischemic heart disease	12 (14.3%)	11 (12.5%)
Chronic liver disease	8 (9.5%)	9 (10.2%)
Chronic respiratory disease	10 (11.9%)	12 (13.6%)
Malignancy	7 (8.3%)	8 (9.1%)
No documented major comorbidity	23 (27.4%)	21 (23.9%)

Patients could have more than one comorbidity; therefore, percentages do not total 100%.

Table 3. Clinical characteristics at recognition of suspected sepsis

Clinical characteristic	Baseline audit (n=84)	Re-audit (n=88)
Temperature $\geq 38^{\circ}\text{C}$	47 (56.0%)	49 (55.7%)
Temperature $< 36^{\circ}\text{C}$	11 (13.1%)	10 (11.4%)
Heart rate $\geq 100/\text{min}$	58 (69.0%)	59 (67.0%)
Respiratory rate $\geq 22/\text{min}$	55 (65.5%)	57 (64.8%)
Systolic BP $< 90 \text{ mmHg}$	19 (22.6%)	20 (22.7%)
SpO ₂ $< 94\%$ on room air*	32 (38.1%)	34 (38.6%)
Altered mental status	24 (28.6%)	25 (28.4%)
Clinically significant oliguria	18 (21.4%)	17 (19.3%)

Clinical characteristic	Baseline audit (n=84)	Re-audit (n=88)
Clinical evidence of hypoperfusion	27 (32.1%)	28 (31.8%)

Table 4. Suspected source of infection

Suspected source	Baseline audit (n=84)	Re-audit (n=88)
Respiratory tract	31 (36.9%)	33 (37.5%)
Urinary tract	19 (22.6%)	20 (22.7%)
Skin/soft tissue	10 (11.9%)	9 (10.2%)
Intra-abdominal	9 (10.7%)	10 (11.4%)
Central nervous system	6 (7.1%)	7 (8.0%)
Bloodstream/line-associated	3 (3.6%)	3 (3.4%)
Other/uncertain source	6 (7.1%)	6 (6.8%)

Table 5. Severity of illness at recognition of suspected sepsis

Severity indicator	Baseline audit (n=84)	Re-audit (n=88)
Sepsis without hypotension	54 (64.3%)	56 (63.6%)
Sepsis with hypotension	19 (22.6%)	20 (22.7%)
Septic shock*	11 (13.1%)	12 (13.6%)
qSOFA 0	24 (28.6%)	27 (30.7%)
qSOFA 1	35 (41.7%)	35 (39.8%)
qSOFA ≥2	25 (29.8%)	26 (29.5%)

The Core Audit Tables

Table 6. Compliance with individual components of the Sepsis Six bundle

Sepsis Six component	Baseline audit n/N (%)	Re-audit n/N (%)	Absolute improvement
Serum lactate measured within 1 hour	35/84 (41.7%)	70/88 (79.5%)	+37.8 percentage points
Blood cultures obtained appropriately	32/84 (38.1%)	68/88 (77.3%)	+39.2 percentage points
Appropriate IV antibiotics within 1 hour	48/84 (57.1%)	76/88 (86.4%)	+29.3 percentage points

Sepsis Six component	Baseline audit n/N (%)	Re-audit n/N (%)	Absolute improvement
IV fluids within 1 hour when indicated	46/70 (65.7%)	62/75 (82.7%)	+17.0 percentage points
Oxygen assessed/provided when indicated	51/63 (81.0%)	75/82 (91.5%)	+10.5 percentage points
Urine output monitoring initiated	39/84 (46.4%)	73/88 (83.0%)	+36.6 percentage points

The denominators for fluids and oxygen are smaller because only patients for whom those interventions were clinically indicated are included.

Table 7. Overall Sepsis Six bundle compliance before and after intervention

Bundle compliance	Baseline audit (n=84)	Re-audit (n=88)
All applicable six components completed within 1 hour	18 (21.4%)	57 (64.8%)
Five components completed	19 (22.6%)	17 (19.3%)
Four components completed	21 (25.0%)	8 (9.1%)
Three components completed	16 (19.0%)	4 (4.5%)
≤2 components completed	10 (11.9%)	2 (2.3%)
Overall complete bundle	18 (21.4%)	57 (64.8%)

Table 8. Timeliness of individual interventions

Intervention	Baseline median time, minutes (IQR)	Re-audit median time, minutes (IQR)
Recognition of sepsis → lactate sampling	74 (48–108)	42 (25–67)
Recognition → blood culture collection	81 (52–121)	45 (28–70)
Recognition → antibiotic administration	68 (43–96)	39 (24–61)
Recognition → IV fluid initiation*	54 (31–83)	37 (22–57)
Recognition → oxygen administration*	31 (18–51)	24 (14–38)
Recognition → urine output monitoring	96 (62–140)	49 (31–76)

Investigation and Treatment Tables

Table 9. Initial investigations and microbiological assessment

Investigation	Baseline audit n (%)	Re-audit n (%)
Complete blood count performed	81 (96.4%)	86 (97.7%)
Renal function/electrolytes assessed	79 (94.0%)	85 (96.6%)
Serum lactate measured	35 (41.7%)	70 (79.5%)
Blood cultures obtained	32 (38.1%)	68 (77.3%)
Urine routine examination	72 (85.7%)	78 (88.6%)
Urine culture sent when indicated	29/43 (67.4%)	36/45 (80.0%)
Chest radiograph performed when indicated	47/52 (90.4%)	50/54 (92.6%)

Table 10. Initial antimicrobial management

Antibiotic-related variable	Baseline audit (n=84)	Re-audit (n=88)
Appropriate empirical IV antibiotic prescribed	68 (81.0%)	82 (93.2%)
Antibiotic administered within 1 hour	48 (57.1%)	76 (86.4%)
Blood cultures obtained before antibiotics where feasible	29 (34.5%)	61 (69.3%)
Antibiotic administration delayed >1 hour	36 (42.9%)	12 (13.6%)
Antibiotic regimen changed after culture/clinical review	19 (22.6%)	23 (26.1%)
No antibiotic documentation available	4 (4.8%)	2 (2.3%)

Outcome Tables

Table 11. Early clinical outcomes during the two audit cycles

Outcome	Baseline audit (n=84)	Re-audit (n=88)
Clinical improvement within first 24 hours	49 (58.3%)	61 (69.3%)
Required escalation to HDU/ICU	17 (20.2%)	16 (18.2%)
Mechanical ventilation required	9 (10.7%)	8 (9.1%)
Vasopressor support required	11 (13.1%)	10 (11.4%)
Developed acute kidney injury	25 (29.8%)	23 (26.1%)
In-hospital mortality	16 (19.0%)	13 (14.8%)

Table 12. Hospital length of stay and disposition

Outcome	Baseline audit (n=84)	Re-audit (n=88)
Hospital stay, median days (IQR)	8 (5-13)	7 (4-11)
Stay ≤5 days	21 (25.0%)	29 (33.0%)
Stay 6-10 days	36 (42.9%)	38 (43.2%)
Stay >10 days	27 (32.1%)	21 (23.9%)
Discharged home	61 (72.6%)	68 (77.3%)
Transferred to another facility	3 (3.6%)	2 (2.3%)
Left against medical advice	4 (4.8%)	5 (5.7%)
Died during admission	16 (19.0%)	13 (14.8%)

Quality Improvement Tables
Table 13. Common barriers to timely completion of the Sepsis Six identified during baseline audit

Identified barrier	Patients affected, n (%)
Delay in recognition/documentation of sepsis	27 (32.1%)
Delay in obtaining blood cultures	25 (29.8%)
Lactate testing not requested/available promptly	34 (40.5%)
Delay in antibiotic administration	30 (35.7%)
Inadequate documentation of intervention times	28 (33.3%)
Delay in establishing/using IV access	14 (16.7%)
Incomplete urine-output monitoring	31 (36.9%)
Nursing workload/staffing constraints	19 (22.6%)
Lack of standardized sepsis checklist	84 (100%)

More than one barrier could be recorded for each patient; therefore, percentages do not total 100%.

Table 14. Quality improvement interventions implemented between the two audit cycles

Intervention	Implementation
Sepsis Six educational session for doctors	Conducted
Nursing staff education	Conducted
Standardized Sepsis Six checklist introduced	Implemented

Intervention	Implementation
Sepsis recognition and first-hour management emphasized during ward rounds	Implemented
Documentation of time of sepsis recognition emphasized	Implemented
Blood-culture-before-antibiotic practice reinforced	Implemented
Early antibiotic administration emphasized	Implemented
Fluid balance and urine-output monitoring reinforced	Implemented
Regular verbal feedback regarding baseline audit findings	Implemented
Re-audit performed after intervention	Completed

Table 15. Achievement of predefined audit standards

Audit criterion	Standard	Baseline compliance	Re-audit compliance	Standard achieved after intervention?
Lactate within 1 hour	≥90%	41.7%	79.5%	No
Blood cultures appropriately obtained	≥90%	38.1%	77.3%	No
IV antibiotics within 1 hour	≥90%	57.1%	86.4%	No
IV fluids when indicated	≥90%	65.7%	82.7%	No
Oxygen when indicated	≥90%	81.0%	91.5%	Yes
Urine output monitoring	≥90%	46.4%	83.0%	No
Complete Sepsis Six bundle	≥90%	21.4%	64.8%	No

Pictorial Presentation of Results

Overview: Clinical Audit Cycle

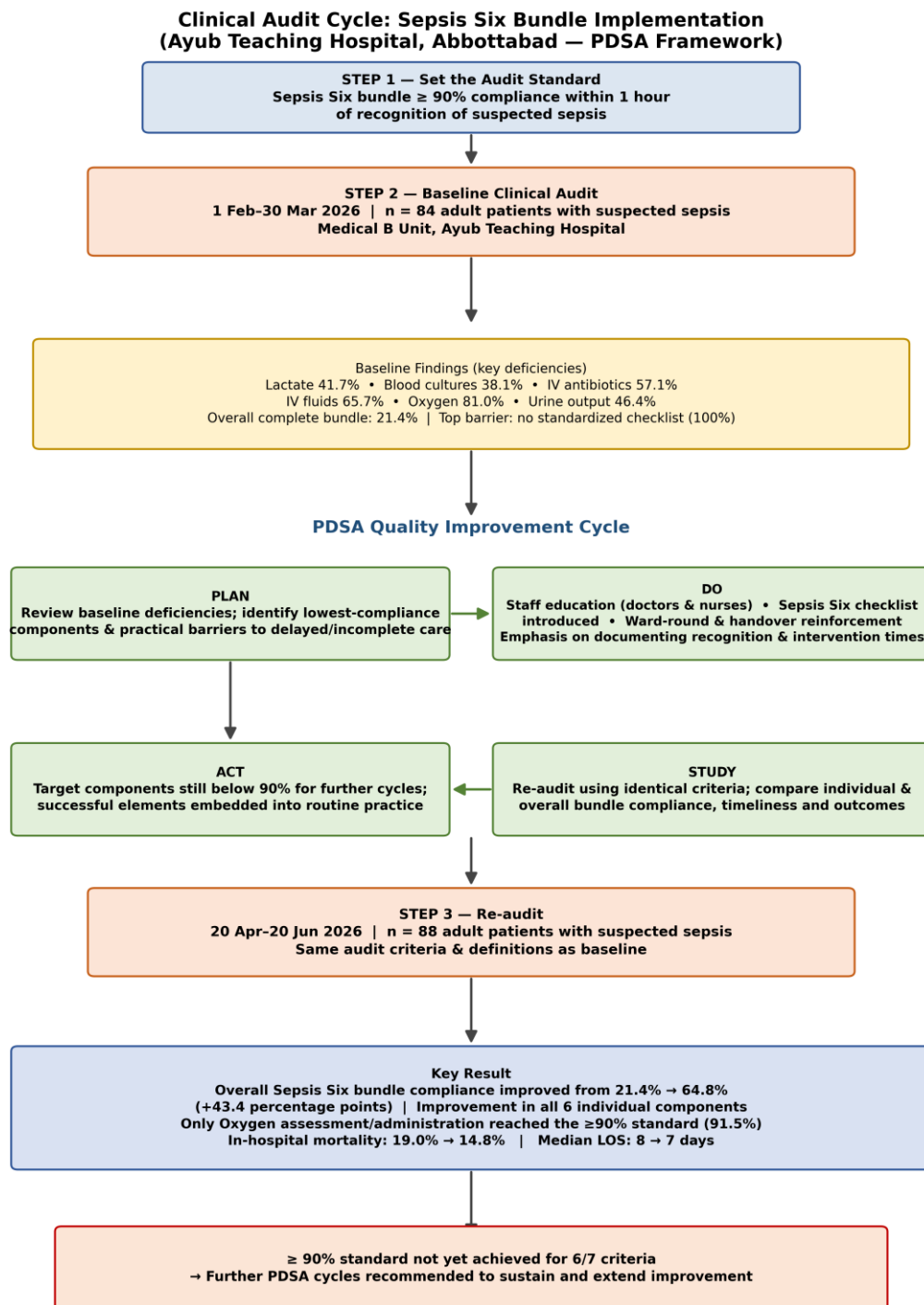


Figure 1. Overall depiction of the two-cycle clinical audit and PDSA quality improvement process, from standard-setting through baseline audit, intervention, re-audit and headline result.

Baseline Characteristics

Figure 1. Demographic characteristics of patients in the two audit cycles

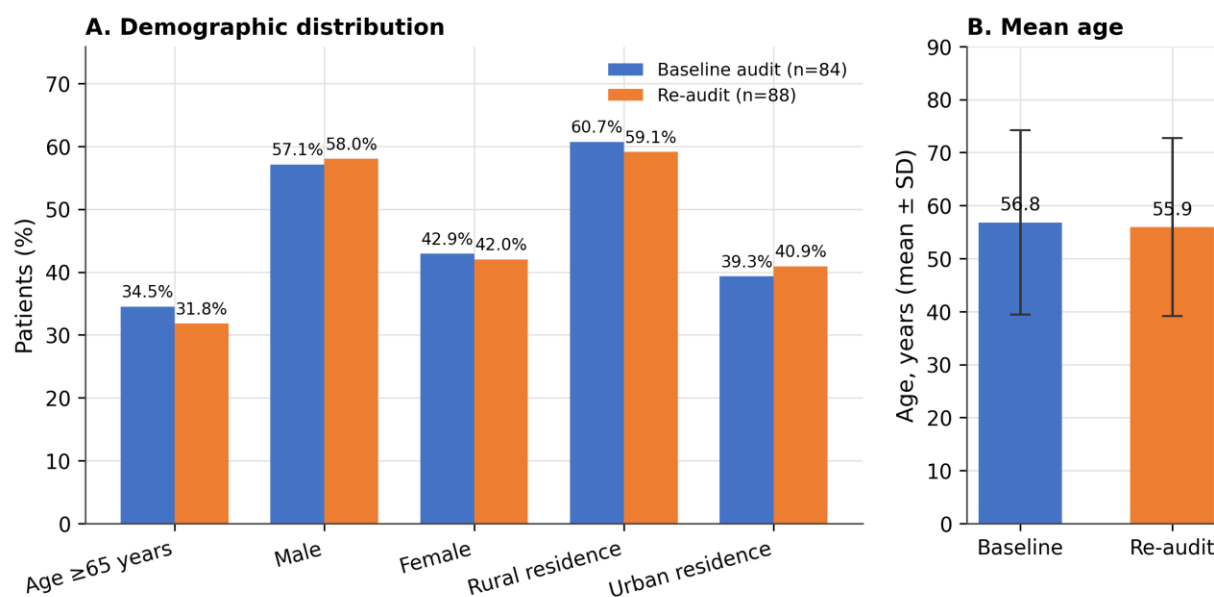
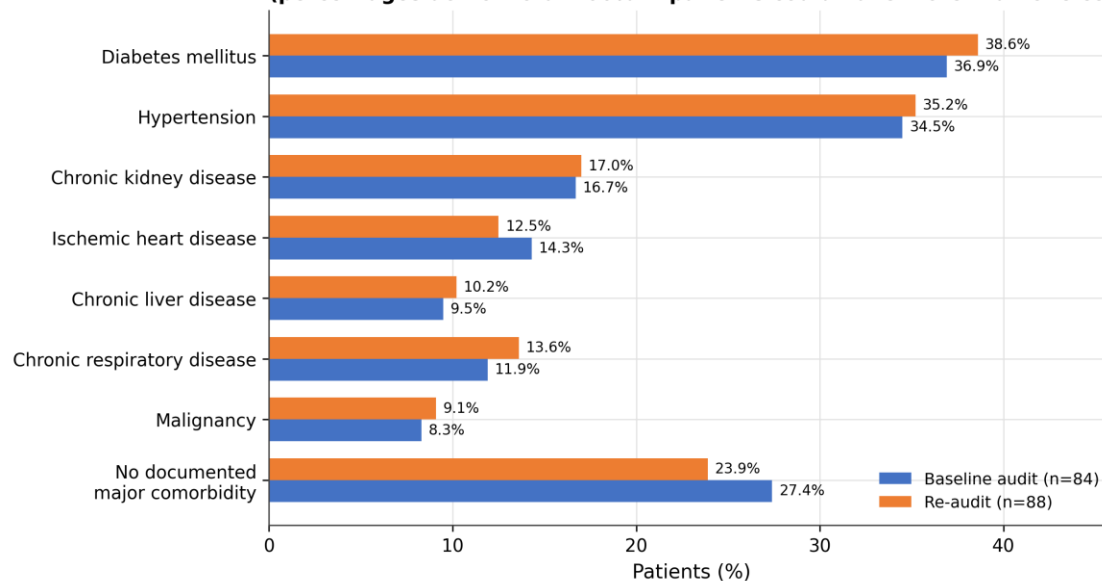


Figure 2. Common comorbidities among patients with suspected sepsis (percentages do not total 100% — patients could have more than one comorbidity)



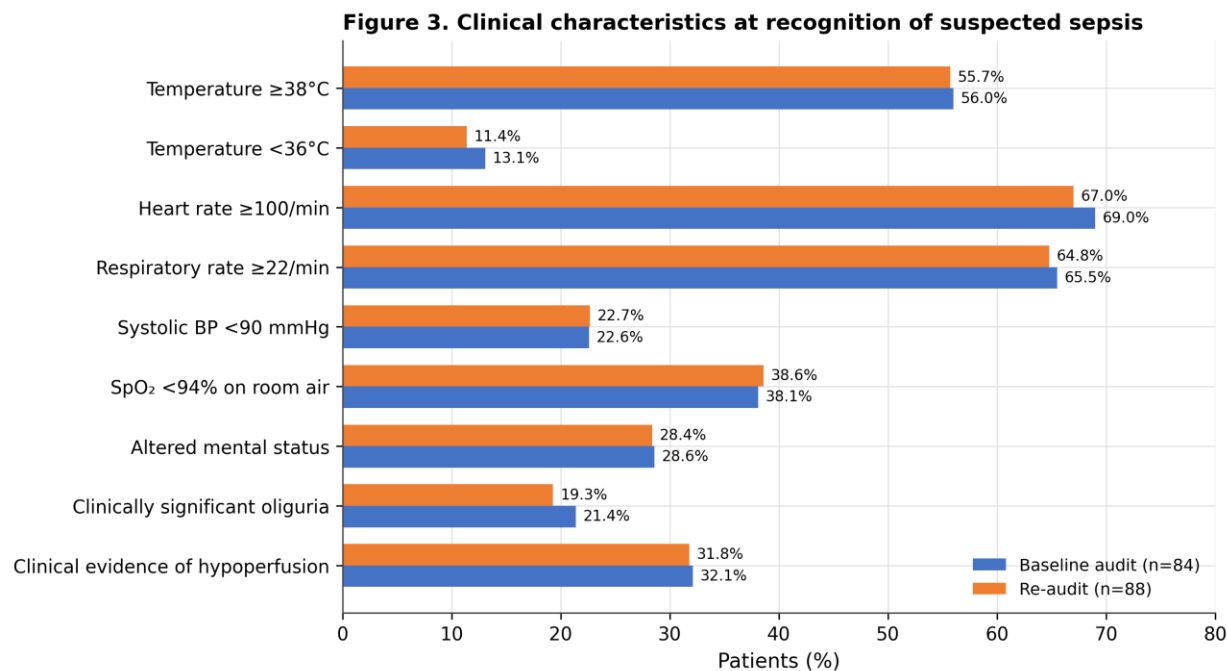


Figure 4. Suspected source of infection

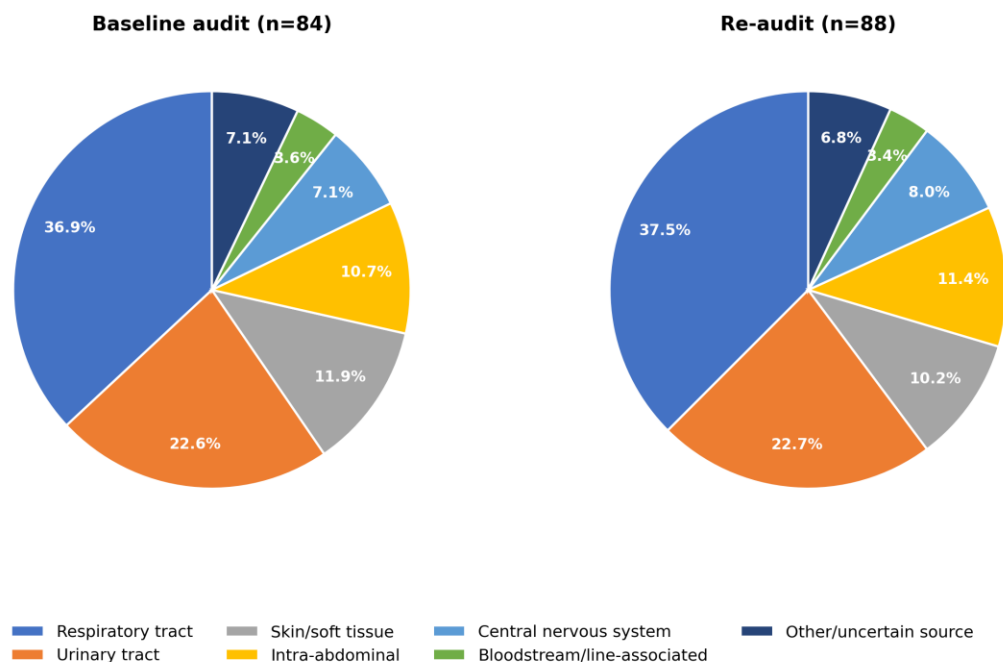
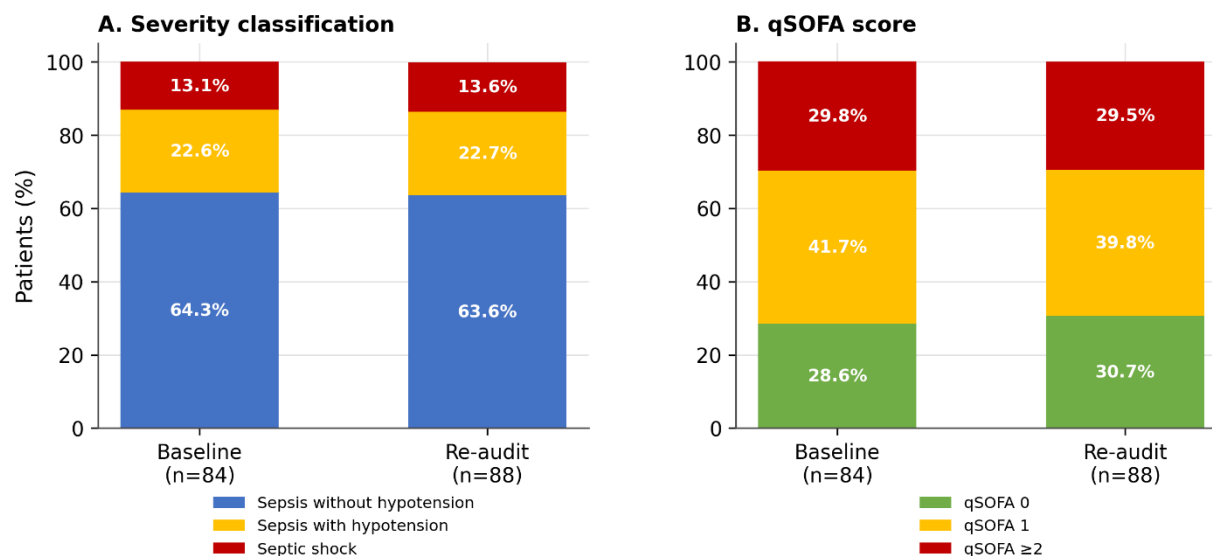


Figure 5. Severity of illness at recognition of suspected sepsis



Core Audit Results

Figure 6. Compliance with individual Sepsis Six components and overall bundle compliance, before and after the quality improvement intervention, against the ≥90% audit standard

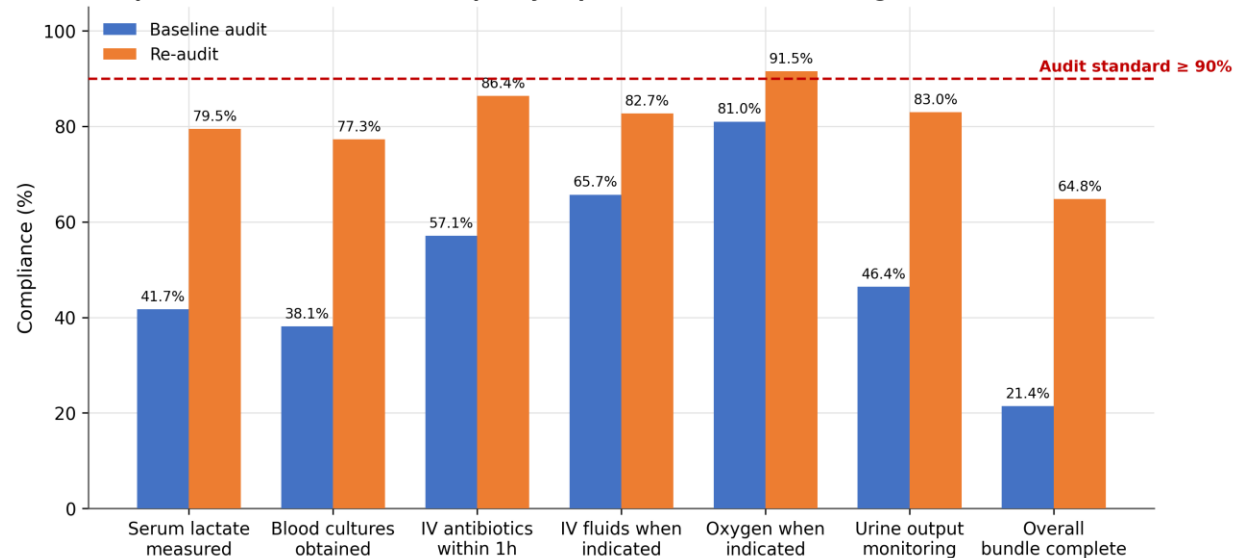


Figure 7. Distribution of the number of applicable Sepsis Six components completed within one hour

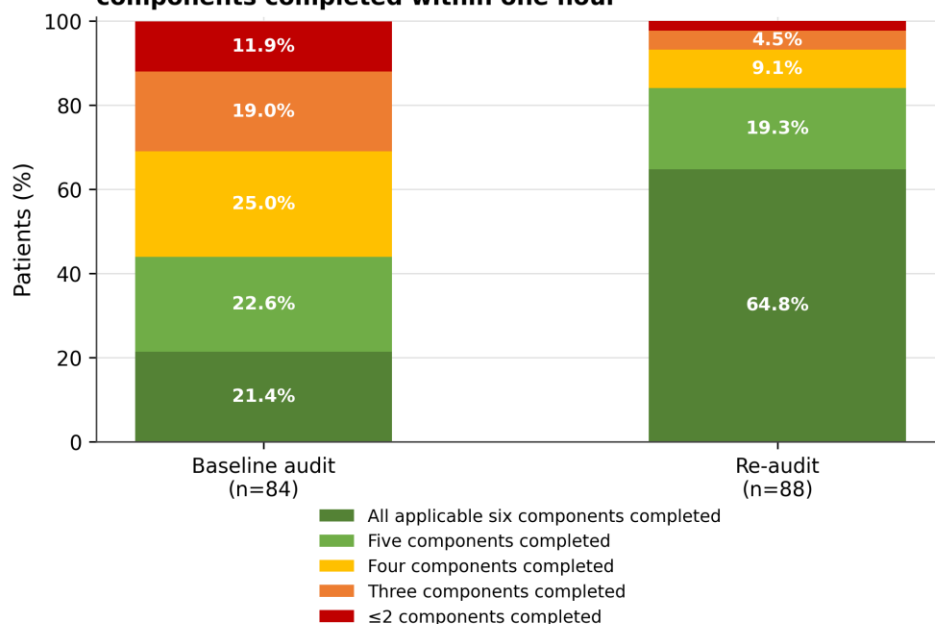
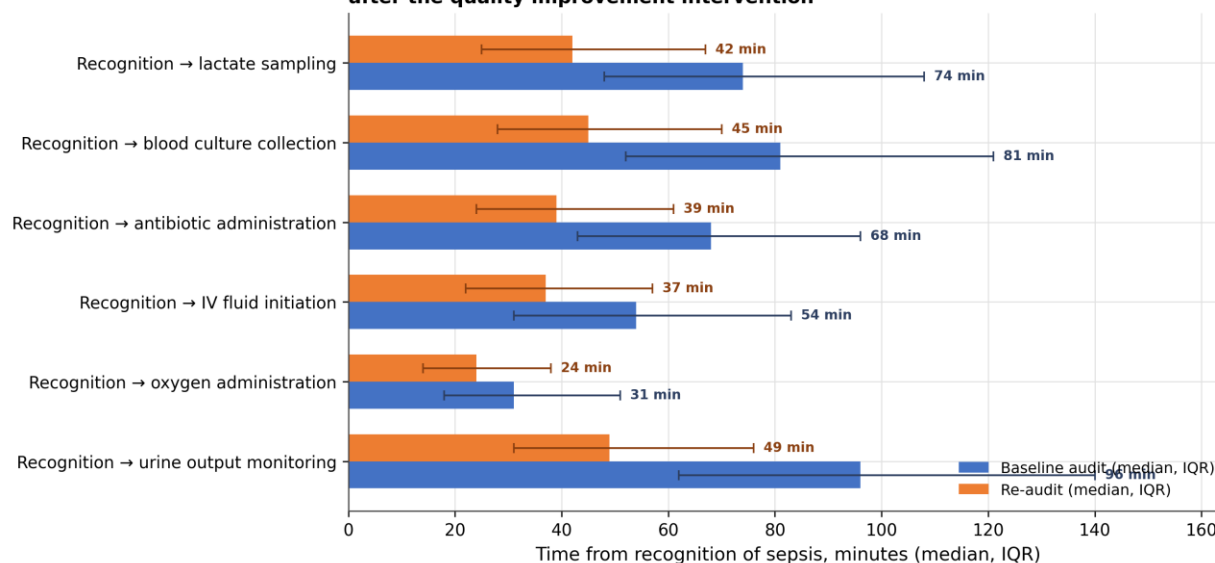


Figure 8. Timeliness of individual Sepsis Six interventions, before and after the quality improvement intervention



Investigations and Treatment

Figure 9. Initial investigations and microbiological assessment (lactate and blood culture results are shown in Figure 6)

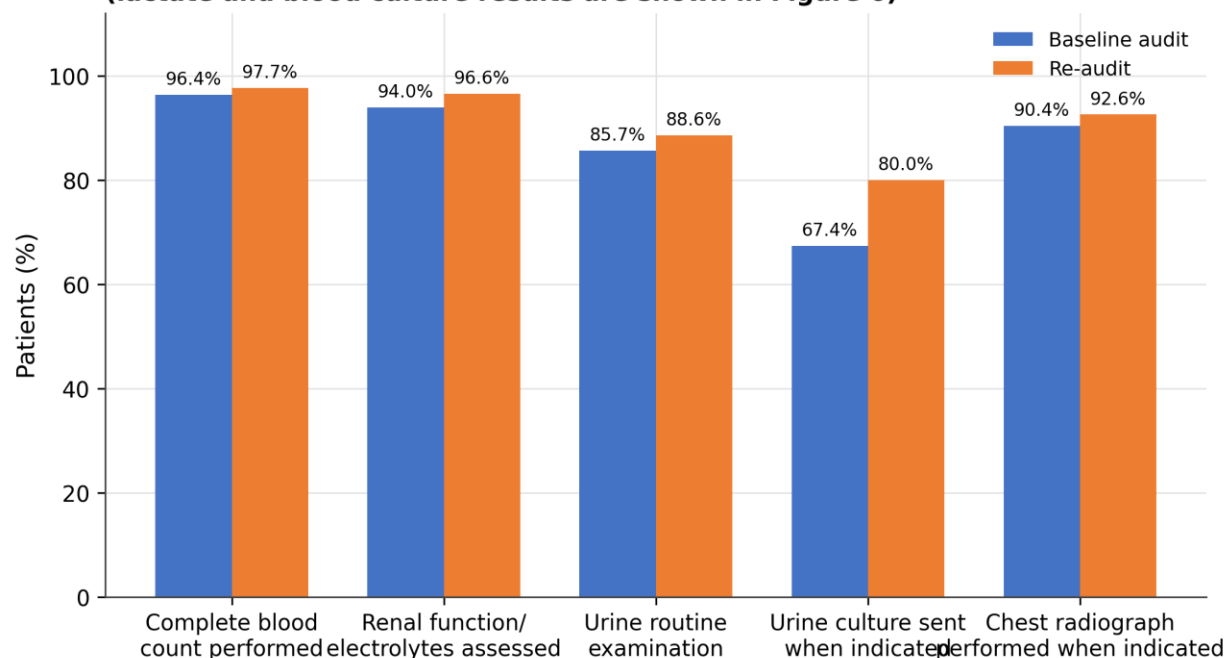
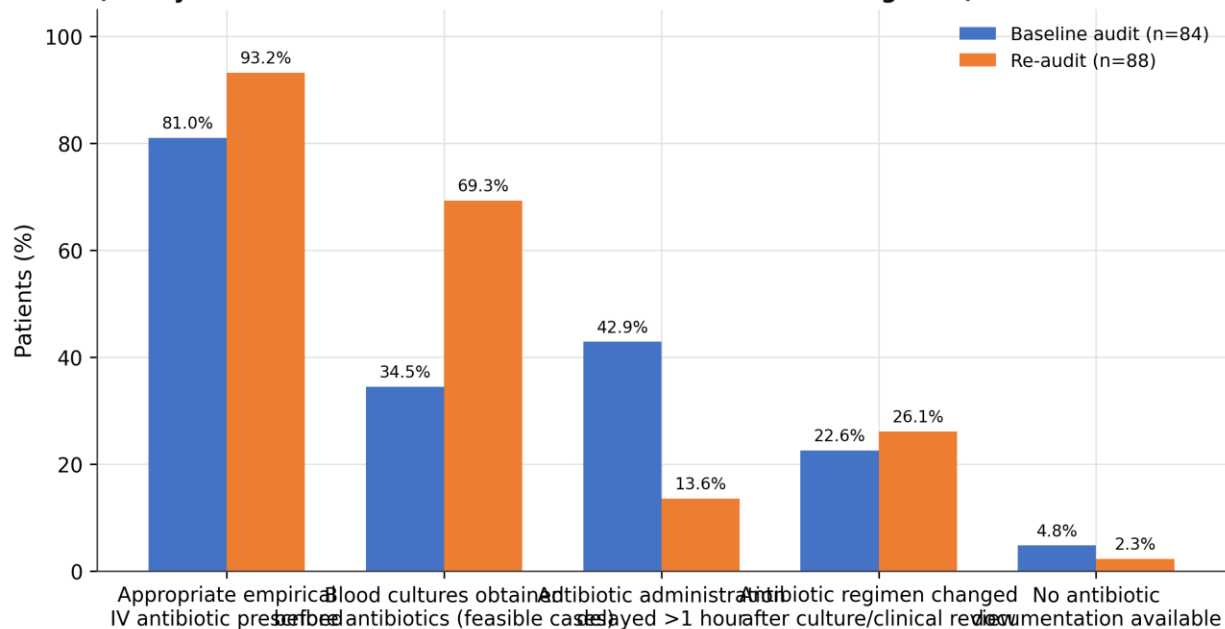


Figure 10. Initial antimicrobial management (timely administration within 1 hour is shown in Figure 6)



Clinical Outcomes

Figure 11. Early clinical outcomes during the two audit cycles

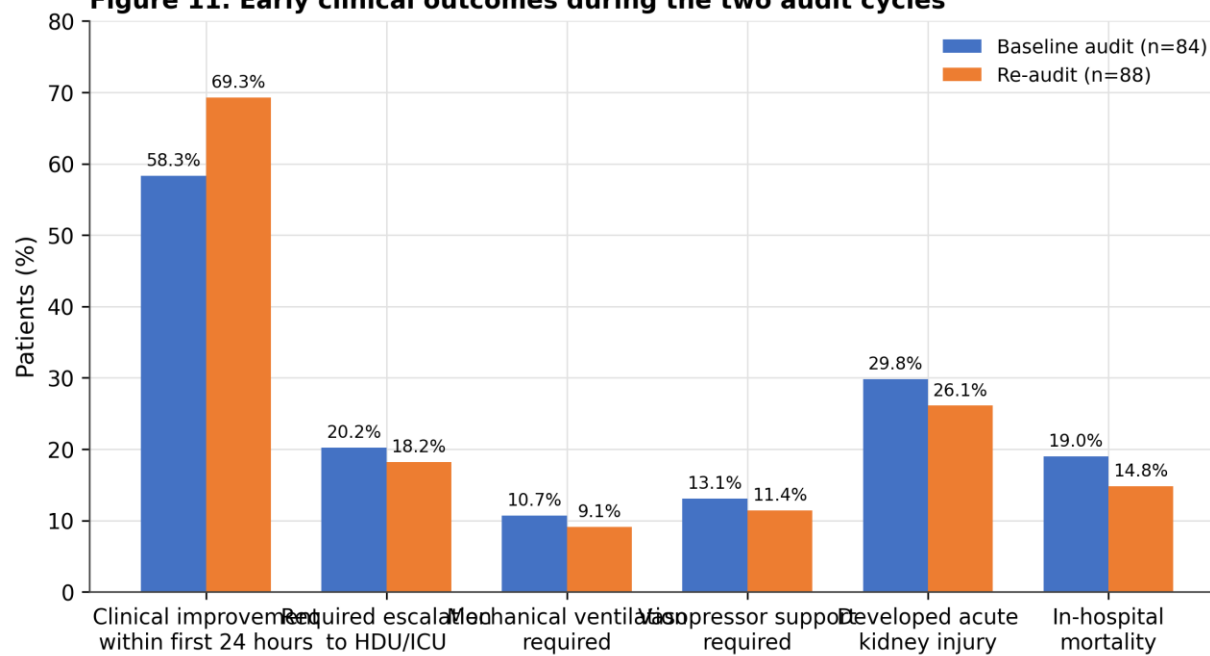
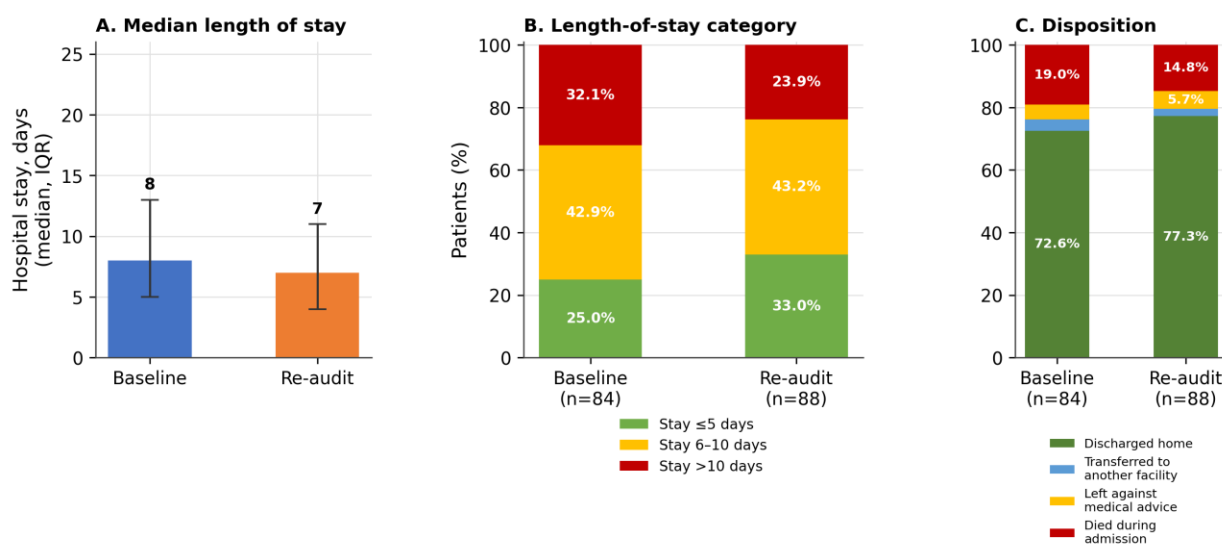
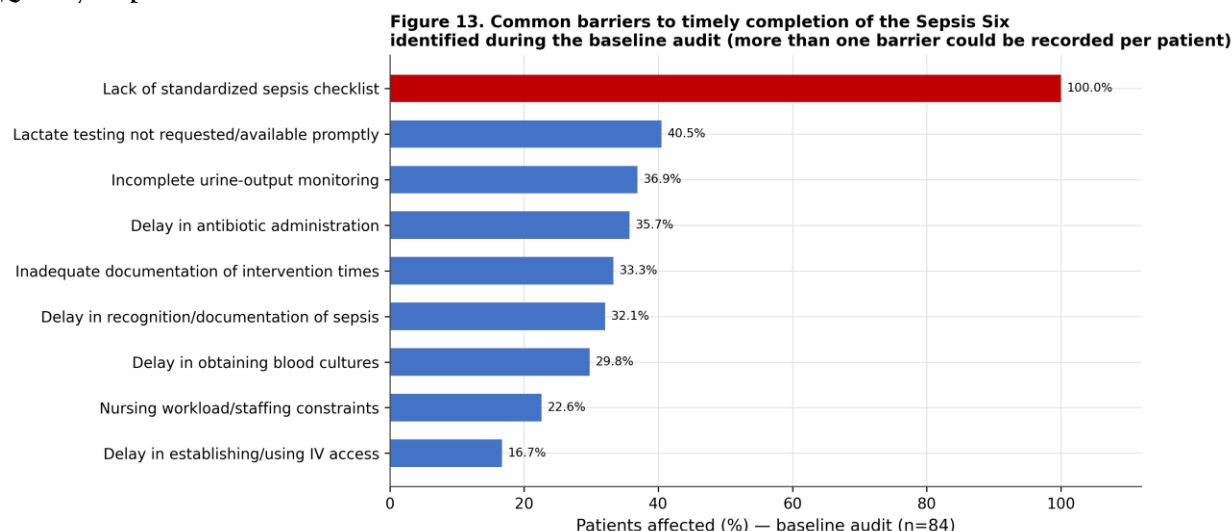


Figure 12. Hospital length of stay and disposition



Quality Improvement



Discussion

Sepsis remains a major cause of morbidity and mortality among hospitalized patients, and its outcome depends to a large extent on how early the condition is recognized and how promptly the initial management is started. Current international recommendations emphasize rapid assessment, early antimicrobial therapy, appropriate fluid resuscitation, measurement of lactate and appropriate monitoring and escalation of care.¹¹ In a busy medical ward, however, the difficulty is often not the absence of knowledge about these individual interventions, but ensuring that they are performed together and within the required time frame. The present clinical audit was therefore undertaken to assess the actual delivery of early sepsis care in the Medical B Unit of Ayub Teaching Hospital, Abbottabad, and to determine whether a simple, locally feasible quality improvement intervention could improve compliance with the Sepsis Six bundle.

The most important finding of this audit was the marked improvement in overall Sepsis Six compliance following the intervention. Complete delivery of all applicable components within the first hour increased from 21.4% during the baseline audit to 64.8% during the re-audit. Although the predefined audit standard of 90% was not achieved, the improvement represents an absolute increase of 43.4 percentage points and indicates a substantial change in the early

management process. This finding is important because the purpose of a clinical audit is not simply to demonstrate whether a target was achieved, but to identify deficiencies in routine practice, introduce a practical intervention and determine whether care subsequently improves.

The baseline findings also showed that the problem was not confined to one particular aspect of sepsis management. Compliance was relatively low with lactate measurement, blood culture collection and urine-output monitoring, while antibiotic administration within the first hour was achieved in just over half of patients. This pattern suggests that early sepsis care in the unit was being delivered inconsistently rather than being completely absent. Some interventions, such as antibiotics and intravenous fluids, were performed more frequently because they are already familiar components of routine management, whereas investigations and monitoring measures requiring coordination between the treating team, nursing staff and laboratory services were more frequently delayed or missed.

Following the intervention, improvement was observed in each of the six components. Lactate measurement increased from 41.7% to 79.5%, while appropriate blood culture collection increased from 38.1% to 77.3%. These were among the largest improvements observed. This is clinically relevant because lactate measurement can assist in identifying patients with tissue

hypoperfusion and in guiding reassessment, while blood cultures provide important microbiological information for subsequent antimicrobial decisions. The Surviving Sepsis Campaign recommends measuring lactate in patients with suspected sepsis and obtaining appropriate microbiological cultures before antimicrobial therapy where this can be achieved without delaying treatment¹¹. The improvement observed in our audit therefore represents better alignment of ward practice with recommended early sepsis care.

Timely administration of intravenous antibiotics improved from 57.1% at baseline to 86.4% after the intervention. Antibiotic delay was one of the practical problems identified during the baseline audit, and the improvement following education, reminders and emphasis on recording the time of sepsis recognition suggests that a relatively simple change in workflow can have a meaningful effect. This finding is consistent with previous quality improvement work showing that educational and organizational interventions can improve adherence to early sepsis bundles. In a multicentre before-and-after study of non-ICU patients, Monti et al. reported improvement in Sepsis Six compliance following a multifaceted quality improvement programme, with compliance increasing at different assessment time points after implementation.²

The improvement in blood culture collection is also noteworthy. At baseline, cultures were appropriately obtained before antibiotics in only 34.5% of patients, increasing to 69.3% after the intervention. This remains below the predefined target, but represents a considerable improvement. In our setting, this may partly reflect the practical difficulties of coordinating sample collection and antibiotic administration in a busy ward. It is important, however, that blood culture collection should not become a reason for delaying antibiotics in a clinically unstable patient. The objective of the intervention was therefore not simply to increase the number of cultures but to improve the sequence and timing of investigations and treatment where feasible.

Intravenous fluid administration among patients in whom fluids were clinically indicated improved from 65.7% to 82.7%. Similarly, oxygen

assessment and administration when indicated increased from 81.0% to 91.5%, making oxygen the only individual Sepsis Six component to cross the predefined 90% audit standard during the re-audit. These findings suggest that interventions which are already familiar to the clinical team may respond relatively quickly to reinforcement and clearer documentation. At the same time, the use of fluids in sepsis requires individual clinical assessment rather than indiscriminate administration. Current guidelines emphasize reassessment of the patient's response and avoidance of fluid administration when there is a risk of harm from fluid overload.¹

Urine-output monitoring showed another substantial improvement, increasing from 46.4% to 83.0%. This was particularly relevant because it represented one of the most frequently identified baseline deficiencies. Urine output is a simple bedside marker that can provide useful information about renal perfusion and response to treatment, but it can easily be overlooked when several urgent interventions are being undertaken simultaneously. The improvement following reinforcement of nursing documentation and fluid-balance monitoring suggests that standardization of responsibilities between doctors and nursing staff was an important part of the intervention.

The improvement in compliance appears to have been related to the **multifaceted nature of the intervention rather than to education alone**. The intervention included staff teaching, introduction of a standardized Sepsis Six checklist, reinforcement during ward rounds and handovers, emphasis on recording the time of recognition and interventions, and feedback on baseline deficiencies. This is consistent with previous Sepsis Six audit work in which active promotion of teamwork and repeated audit-feedback resulted in a substantial improvement in adherence to the protocol. In one audit and re-audit study, appropriate management increased from 1% at baseline to 67% after implementation of the Sepsis Six approach.¹³ Similarly, a study evaluating the introduction of the Sepsis Six on general wards reported high overall bundle compliance after implementation and

demonstrated improvement in early clinical observations following treatment.¹⁴

Our findings are also consistent with more recent quality improvement literature. A multicentre study involving emergency departments and medical wards found that a multifaceted quality improvement programme improved compliance with a simplified one-hour Sepsis Six bundle.¹² Other quality improvement studies have similarly shown that standardized processes, education, team-based responses and feedback can improve completion of time-sensitive sepsis interventions.¹⁵ These findings support the approach used in the present audit, particularly because the intervention was designed around the existing resources and workflow of the Medical B Unit rather than relying on an expensive or highly specialized sepsis response system.

The local context is important when interpreting these findings. Pakistan has a substantial burden of sepsis, while published national data remain relatively limited. A recent review of sepsis in Pakistan reported that respiratory infections were the commonest source followed by urinary infections and highlighted poor adherence to recommended sepsis management practices. The review also emphasized the need for simple, cost-effective and context-specific approaches to improve sepsis care.¹⁶ The pattern observed in the present audit, with respiratory infection being the commonest suspected source followed by urinary infection, is therefore broadly in keeping with the available Pakistani literature. The improvement achieved through a relatively simple intervention is particularly relevant in a tertiary-care government hospital where resources and staffing may not permit implementation of more elaborate sepsis programmes.

The demographic and clinical characteristics of the two audit cycles were broadly comparable. The mean age was approximately 56 years in both cycles, with a slight male predominance, and diabetes mellitus and hypertension were the most frequently documented comorbidities. Respiratory infection was the leading suspected source of sepsis in both cycles. Importantly, the proportion of patients with hypotension, septic shock and other markers of severity was also similar between the two periods. Although this

does not eliminate the possibility of differences in case mix, it provides some reassurance that the improvement in process compliance was not simply due to a substantially less severely ill population during the re-audit.

The reduction in median time to individual interventions provides additional support for the effectiveness of the intervention. The median time from recognition of suspected sepsis to antibiotic administration decreased from 68 minutes to 39 minutes, while the median time to lactate sampling decreased from 74 to 42 minutes and blood culture collection from 81 to 45 minutes. These changes are particularly important from a quality improvement perspective because the intervention was intended not merely to increase documentation of whether an intervention occurred, but to make the initial response more timely. The Sepsis Six provides a practical framework for bringing these interventions together during the first hour of care.¹⁴

There was also an observed reduction in in-hospital mortality from 19.0% in the baseline cycle to 14.8% in the re-audit, accompanied by a small reduction in median hospital stay from 8 to 7 days. The proportion requiring HDU/ICU escalation and mechanical ventilation also decreased slightly. These findings are encouraging, but they should be interpreted cautiously. The present project used a before-and-after clinical audit design without randomization or adjustment for all potential differences between the two periods. Therefore, the observed reduction in mortality cannot be attributed directly to the Sepsis Six intervention. Other factors, including differences in disease severity, source of infection, antimicrobial susceptibility, availability of beds, staffing, referral patterns and individual clinical decision-making may have contributed to the observed outcomes.

This cautious interpretation is supported by the wider literature. Some observational studies and quality improvement programmes have reported improved mortality alongside improved bundle compliance.^{12,17} However, the evidence is not uniform. A recent systematic review examining sepsis management bundle compliance and mortality found considerable methodological heterogeneity and concluded that the available

evidence was insufficient to establish a moderate- or high-level causal effect of bundle implementation on mortality.¹⁸ This is an important consideration for the present audit. The strongest conclusion from our findings is therefore that the intervention **improved the delivery and timeliness of early sepsis care**, rather than that it definitively reduced mortality.

One of the useful findings of the audit was the identification of practical barriers to care. Delayed lactate testing, incomplete urine-output monitoring, delays in blood culture collection, delayed antibiotic administration and inadequate documentation of intervention times were common problems during the baseline cycle. The absence of a standardized Sepsis Six checklist was also identified as an important system-level gap. These findings reinforce the idea that sepsis management is a team process. Even when the treating doctor recognizes sepsis promptly, completion of the bundle may depend on nursing staff, laboratory services, availability of intravenous access, medication administration and documentation. A checklist therefore serves not only as a reminder but also as a way of assigning and communicating tasks between members of the healthcare team.

The audit also demonstrated that improvement in practice does not necessarily occur uniformly across all components. Despite considerable improvement, lactate measurement, blood culture collection, urine-output monitoring and overall bundle completion remained below the 90% standard. This is an important finding rather than a failure of the intervention. It indicates that the first PDSA cycle improved the process but did not completely close the performance gap. In a busy tertiary-care medical unit, sustained improvement may require repeated audit-feedback cycles, continued staff education, clearer documentation responsibilities and further attention to laboratory and nursing workflow. Recent work on improving sepsis care in low-resource settings similarly emphasizes practical, context-specific interventions and reliable systems rather than reliance on guidelines alone.

Strengths and limitations

The main strength of this project is its practical design. It assessed actual bedside practice in a real medical unit, identified specific deficiencies, implemented a low-cost intervention and then reassessed the same processes using the same criteria. The use of a predefined audit standard and PDSA methodology also allowed the intervention to be evaluated systematically rather than simply providing an educational session without measuring its effect. The project is particularly relevant to a Pakistani tertiary-care setting because the intervention did not depend on expensive technology, additional specialist staff or a dedicated sepsis team.

There are, however, several limitations. First, the audit was conducted in a single medical unit of one tertiary-care hospital, so the findings may not be directly generalizable to other hospitals or specialties. Second, the sample size was relatively small, making the findings vulnerable to temporal variation. Third, some information was dependent on documentation in clinical and nursing records; therefore, an intervention that was performed but not documented may have been classified as incomplete. Fourth, the before-and-after design cannot establish causality between improved Sepsis Six compliance and clinical outcomes. Finally, although the intervention improved compliance substantially, the predefined 90% standard was not reached for the overall bundle, indicating that further PDSA cycles are required.

Conclusion

This clinical audit demonstrated a clear gap between recommended early sepsis management and actual practice in the Medical B Unit of Ayub Teaching Hospital, Abbottabad. At baseline, complete compliance with all applicable components of the Sepsis Six within the first hour was low, with particular deficiencies in timely lactate measurement, blood culture collection, antibiotic administration and urine-output monitoring. Implementation of a locally feasible, multidisciplinary PDSA-based intervention, including staff education, a standardized Sepsis Six checklist, reinforcement during ward rounds and handovers, improved documentation of

intervention times, and audit feedback, was associated with a substantial improvement in the delivery and timeliness of early sepsis care. Overall Sepsis Six compliance increased from **21.4% in the baseline audit to 64.8% in the re-audit**, with improvement observed across all six individual components. Oxygen assessment and administration when clinically indicated was the only component to achieve the predefined **≥90% audit standard**. Although the intervention produced a considerable improvement, the overall target of 90% compliance was not achieved. This indicates that a single PDSA cycle was insufficient to completely close the existing performance gap. Continued reinforcement, regular audit and feedback, improved coordination between medical, nursing and laboratory staff, and further PDSA cycles are therefore required to sustain the improvement and achieve a higher level of compliance.

The observed reduction in mortality and hospital length of stay following the intervention is encouraging but should be interpreted cautiously, as this before-and-after audit was not designed to establish a causal relationship between Sepsis Six compliance and patient outcomes. The main achievement of this project was improvement in the **timeliness, consistency and standardization of early sepsis management**.

Overall, this audit suggests that a simple, low-cost and locally adapted Sepsis Six pathway can substantially improve early sepsis care in a busy tertiary-care medical unit. Continued monitoring and repeated audit cycles should be used to consolidate these gains and work towards achieving the predefined 90% standard in routine clinical practice at Ayub Teaching Hospital, Abbottabad.

Additional Information

Conflicts of Interest: None

Payment/Services Information: All authors state that no financial assistance or support was received from any organization in relation to this submitted work.

Financial Relationships: All authors confirm that they have no current or prior financial

relationships with any organizations that may have a vested interest in the submitted work.

Acknowledgements: We would like to express our heartfelt appreciation to the HOD, consultants, registrar of medical B Ward of Ayub Teaching Hospital, located in Abbottabad, Khyber Pakhtunkhwa, Pakistan, for their exceptional support and cooperation throughout the data collection and intervention process.

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- **Critical Review & Final Approval; Waqar Ahmad¹, Huma Mushtaq²**

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