Journal of Biomedical Sciences | ISSN: 2960-9356
Research Article Peer-review, Open Access

Comparative Study of Antibiotic Use During the Decisive Period Versus Non-Use in Bacterial Infections a Prospective-Retrospective Comparative Clinical Study — Samarra General Hospital, Samarra, Salah ad-Din Governorate, Iraq

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Abstract

The first 24 hours after onset of bacterial infection is the most critical period in infectious disease treatment. The failure to provide adequate antibiotic treatment within this period is correlated with exponential escalation of bacterial load, inflammatory response and lethality. Iraq is facing many issues concerning the preparedness of hospitals and antimicrobial stewardship, and there is a need to urgently develop clinical evidence locally to support policy and practice on the institutional level. Objective to compare the clinical outcomes in patients who received antibiotic treatment within the "decision time window" with those who did not during the calendar year 2025 at Samarra General Hospital and to inform actionable antibiotic stewardship recommendations based on the results. A combined prospective-retrospective cohort study of 480 adult inpatients with confirmed bacterial infections. Group A (n=240) received appropriate antibiotics within 0–24 hours of admission (decisive period); Group B (n=240) experienced delayed or absent antibiotic therapy beyond 24 hours. In-hospital mortality, complication rates, length of stay and admission to the intensive care unit (ICU) were all included as outcomes. In-hospital mortality was 7.5% in Group A versus 36.7% in Group B ($p<0.001$; OR=7.12, 95% CI: 3.98–12.74). Other statistics show that the mean hospital stay was 5.2 days and 14.6 days respectively. Septic shock was noted in 4.6% of the Group A patients, and 31.3% of the Group B patients. Complication rate was 17.1% in Group A and 63.3% in Group B. Starting antibiotics in the critical time window provides a significant survival benefit, and strongly lowers the burden of disease, hospital resource use, and the severity of complications. Antibiotic stewardship protocols need to be formalized at Samarra General Hospital and micro-level infrastructure needs to be strengthened to support the provision of antibiotic treatment, to help achieve standards at the decisive periods. The antibiotic therapy was indicated only when the decisive period had arrived, with the onset of bacterial infection in the patients, and the bacteria were found at the Samarra General Hospital in Iraq, which caused sepsis leading to mortality in the patients. The antibiotic therapy was not indicated while the patients were still at home and in the initial stages of the infection.

Keywords: Antibiotics, decisive period, bacteremia, infection, penicillin.

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Introduction

Treatment for bacterial infections continues to be antibiotic therapy, but time is of the essence with antibiotics. The 'decisive period', defined in the modern literature on infectious diseases as the first 24 hours after clinical onset of a bacterial infection, is the time frame when antimicrobial therapy is most likely to stop pathogen multiplication, to modify the host inflammatory response and to prevent the development of life-threatening systemic disease. Worldwide bacterial infections continue to be a massive problem. Together, lower respiratory tract infections, bloodstream infections and bacterial meningitis are responsible for more than 7.7 million deaths per year according to the Global Burden of Disease study 2024 [1], [2]. Sepsis is systemic response to unchecked bacterial infection which is responsible for more deaths in the world than many cancers and becomes increasingly lethal the longer it is untreated [3], [4]. Guidelines for antibiotics for sepsis in general, including in the Surviving Sepsis Campaign (2021 update), call for giving antibiotics within 1 hour of the recognition of sepsis — requiring institutional readiness and quick decision-making processes [5], [6].

Despite its ongoing post-conflict reconstruction and capacity building, Iraq's health system has ongoing problems with access to diagnostic resources, inconsistent evidence-based clinical guidelines at the institution level, and inconsistent pharmaceutical supply chains [7], [8]. Samarra General Hospital is the main public referral hospital in the Salah ad-Din Governorate, and provides services to a catchment area of more than 500,000 people and is a victim to these systemic pressures every day. Samarra General Hospital's Department of Internal Medicine and Infectious Diseases (IMID) began a structured, real-world, comparative study in 2025 to assess the actual implementation of antibiotic standards during the critical period and to quantify the clinical impact of deviation from these standards in Iraq, amidst the backdrop of the emergence of antimicrobial resistance and the ongoing national health system reform initiatives [9]. This paper outlines the results of the study and offers actionable evidence to help improve hospital antibiotic prescribing practices and to draw national guidelines for antibiotic stewardship.

Study Objectives

The primary and secondary objectives of this study were to:

Primary Objective: To compare in-hospital all-cause mortality rates of patients receiving antibiotics within the decisive period (Group A) and those receiving delayed or no antibiotic therapy (Group B) in 2025 in Samarra General Hospital.

Secondary: To evaluate the incidence of serious events such as septic shock, acute organ failure (renal, hepatic, respiratory), admission to the intensive care unit (ICU) and requirement of mechanical ventilation in both groups.

Secondary: To measure the differences in resource utilization and mean length of hospital stay between groups.

Secondary: To document the microbiological profile of the bacteria isolated and the treatment with antibiotics given in the clinical setting of Samarra general hospital.

Secondary: Determine institutional obstacles to antibiotic delivery during the critical period and design interventions to address the identified areas of need.

Materials and Methods

Study Design

The design of this study was a Prospective -Retrospective Cohort Design. The prospective run of eligible patients was carried out in the time interval January 2025 to August 2025 and the retrospective review of the clinical records was done along the same time period (January to March 2025) to augment the dataset. All analyses were carefully performed and data was accessed at September 30, 2025.

Study Setting

Samarra General Hospital is a 380-bed public tertiary referral hospital in the central area of Samarra, Salah ad-Din Governorate, under the supervision of the Iraqi Ministry of Health. It comprises departments of Internal Medicine, Surgery, Pediatrics, Obstetrics and Gynecology, Orthopedics, Neurology and Intensive Care Unit (12 bed). The Emergency Department receives an average of 180 patients per day. Microbiological culture services are available on-site with a standard turnaround of 48–72 hours for blood cultures.

Inclusion and Exclusion Criteria

Eligible patients were adults (≥18 years) admitted to Samarra General Hospital with a diagnosis of confirmed or clinically suspected bacterial infection, based on two or more of the following: fever (>38.3°C) or hypothermia (<36°C); elevated white blood cell count (>12,000/μL or <4,000/μL); elevated C-reactive protein (>50 mg/L); elevated procalcitonin (>0.5 ng/mL); or a positive bacterial culture from blood, urine, sputum, cerebrospinal fluid, or wound [10].

Patients were excluded if: the infection was confirmed as viral, fungal, or parasitic; antibiotic therapy was initiated prior to hospital presentation within 72 hours; the patient was under 18 years of age; the medical record was incomplete for key variables; or the patient carried a known primary immunodeficiency, active HIV infection with CD4 <200, or was receiving immunosuppressive chemotherapy.

Group Assignment

Group A (Decisive-Period Treatment, n=240): patients for whom the first dose of antibiotic recorded in nursing administration charts and in pharmacy dispensing records was an antibiotic with in-vitro or guideline based activity against the likely pathogen within 24 hours of hospital admission.

Group B: Delayed or Absent Treatment (n=240): patients for whom first antibiotic was not given within 24 hours of admission, or for whom no antibiotic was prescribed during hospitalisation. Documented causes of delay included: Diagnostic uncertainty (38.7%), drug unavailability (21.3%), prescriber delay (24.2%), and patient/family refusal (15.8%).

Outcome Variables

Primary outcome: All-cause mortality in-hospital. Secondary outcomes included: incidence of septic shock; acute kidney injury (KDIGO stage 2 or above); acute respiratory failure requiring ventilatory support; ICU admission; length of hospital stay (days); and clinical cure rate at discharge [11].

Statistical Methods

Data were analyzed statistically, using the IBM SPSS statistics 29.0 software package (IBM Corp., Chicago, USA). Continuous variables were summarized as means ± standard deviation (SD) and compared using independent samples t-tests. Categorical data were presented as percentages and tested for significance using chi-square or Fisher's exact tests, as applicable. Multivariate logistic regression was used to determine the independent predictors of mortality, with adjustment made for age, sex, Charlson Comorbidity Index (CCI) score and at-admission SOFA score and infection type. Throughout, a p-value of less than 0.05 was deemed to be statistically significant. All tests were performed in a two-tailed manner.

Results

Baseline Characteristics

There were 480 patients who fulfilled the inclusion criteria and were enrolled. The mean age of participants was 46.9 ± 13.7 years in Group A and 48.4 ± 15.1 years in Group B (p=0.19). Males constituted 56.3% of Group A and 53.8% of Group B (p=0.56). Charlson Comorbidity Index was not significantly different between the two groups (2.1 vs. 2.3, p=0.32). Type 2 diabetes mellitus (33.5%), hypertension (26.0%) and chronic kidney disease (13.8%) were the most common comorbidities.

Table 1. Baseline demographic and clinical characteristics of study groups. No significant between-group differences were detected (all p>0.05).

Baseline Variable	Group A — With Antibiotics (n=240)	Group B — Delayed / No Antibiotics (n=240)
Mean age, years (±SD)	46.9 ± 13.7	48.4 ± 15.1
Male sex, n (%)	135 (56.3%)	129 (53.8%)
Diabetes mellitus, n (%)	79 (32.9%)	82 (34.2%)
Hypertension, n (%)	63 (26.3%)	62 (25.8%)
Chronic kidney disease, n	31 (12.9%)	35 (14.6%)

(%)		
Charlson Comorbidity Index (mean)	2.1	2.3
Mean SOFA score at admission	4.1 ± 2.2	4.4 ± 2.5

Infection Profile

There was no difference in the pattern of infection types. Community-acquired pneumonia was the most frequent diagnosis (27.3%), followed by complicated urinary tract infection / urosepsis (20.4%), primary bacteremia / sepsis of undetermined source (18.5%), intra-abdominal infection (12.7%), skin and soft tissue infection (11.5%), and bacterial meningitis (5.8%). The remainder 3.8% was due to other causes such as infective endocarditis and osteomyelitis. The most frequently isolated organisms were Escherichia coli (29.6%), Klebsiella pneumoniae (21.3%), Staphylococcus aureus (17.8%), Streptococcus pneumoniae (13.2%), Pseudomonas aeruginosa (9.4%) and Acinetobacter baumannii (5.1%). The high prevalence of ESBL producing Gram-negative bacteremia isolates (34.1%) reported reflects the increasing burden of antimicrobial resistance in the Samarra region.

Primary Outcome: Mortality

In-hospital all-cause mortality was 7.5% (18/240) in Group A and 36.7% (88/240) in Group B. This difference was significantly different ($p<0.001$; unadjusted OR=7.12, 95% CI: 3.98–12.74). Delayed or lack of antibiotic treatment was the strongest independent risk factor for mortality even after adjusting for age, SOFA score Charlson Comorbidity Index, and infection type (adjusted OR=5.84, 95% CI: 3.11–10.97; $p<0.001$). The highest mortality rate was seen with primary bacteremia without source (Group B: 52.3%) and bacterial meningitis (Group B: 64.3%), which highlights the time sensitivity of these two diagnoses.

Table 2. Comparison of primary and secondary clinical outcomes between Group A and Group B. * Statistically significant ($p<0.05$).

Outcome Measure	Group A (n=240)	Group B (n=240)	p-value
In-hospital mortality	**7.5% (18/240)**	**36.7% (88/240)**	<0.001 *
Mean hospital stay, days (±SD)	5.2 ± 2.0	14.6 ± 6.1	<0.001 *
ICU admission rate	9.6%	45.4%	<0.001 *
Septic shock incidence	4.6%	31.3%	<0.001 *
Acute kidney injury (KDIGO ≥2)	8.3%	29.6%	<0.001 *
Respiratory failure / ventilation	3.8%	21.3%	<0.001 *
Overall complication rate	17.1%	63.3%	<0.001 *
Full clinical recovery at discharge	92.5%	63.3%	<0.001 *
Readmission within 30 days	6.3%	18.8%	0.001 *

Secondary Outcomes

Patients in Group A were admitted to the ICU at a rate of 9.6%, compared with 45.4% in Group B. Mean ICU length of stay for admitted patients was 3.1 days (Group A) versus 9.7 days (Group B). Septic shock occurred in 11 patients in Group A (4.6%) versus 75 patients in Group B (31.3%). Acute kidney injury requiring nephrology consultation developed in 8.3% of Group A patients compared with 29.6% in Group B. Thirty-day hospital readmission was also significantly lower in Group A (6.3% vs. 18.8%, p=0.001).

Antibiotic Regimens and De-escalation

In Group A, the most commonly prescribed empirical regimens were: piperacillin-tazobactam (31.3%), third-generation cephalosporins — predominantly ceftriaxone — (27.5%), carbapenem-based therapy for high-risk presentations (16.3%), and fluoroquinolone monotherapy for urinary or respiratory sources (14.2%). De-escalation to narrow-spectrum agents following culture and sensitivity results was documented in 68.8% of Group A patients within 72 hours, consistent with antimicrobial stewardship best practices.

In Group B, antibiotic administration — when it eventually occurred — was more frequently inappropriate for the isolated organism (42.5% susceptibility mismatch) compared with Group A (8.3%), further compounding adverse outcomes in the delayed-treatment cohort.

Discussion

The findings from this study offer robust, local evidence that antibiotic usage during the critical window of bacterial infection does provide significant survival advantage to the patients who received treatment at the Samarra General Hospital. The adjusted mortality risk was reduced by nearly 5-fold (from 36.7% to 7.5%) with a clinically and statistically significant improvement. Overall, these results are similar to those of the landmark international trials such as Surviving Sepsis Campaign trials, ProMISe [12], ARISE [13], and ProCESS [14] multicenter randomized trials, and the study by Kumar et al. [15] that found that 1 hour of delay in effective antibiotic treatment for septic shock is associated with an increase in the mortality rate of approximately 7.6%. Particularly noteworthy is the subgroup analysis revealing mortality rates of 52.3% and 64.3% in Group B patients presenting with primary bacteremia and bacterial meningitis respectively [16]. These figures are similar to those reported in older literature from pre-antibiotic times, and demonstrate the importance of the consequences of delayed antibiotic delivery – namely, pharmacologically and biologically equivalent to withholding antibiotic therapy altogether – within the modern hospital environment.

The 34.1% of the ESBL-producing Gram-negative organisms on bacteremia isolates is a significant challenge in the institution. In a significant number of patients, empirical antibiotic therapy with first generation antibiotics will be microbiologically inappropriate as ESBLs are resistant to most penicillins and cephalosporins. This underlines the need for both institutional antibiogram data, regularly updated for guidance of empirical treatment, and rapid diagnostic platforms like matrix-assisted laser desorption ionization-time of flight (MALDI-TOF) mass spectroscopy that can identify an organism in hours, not days. The obstacles to better performance for Group B patients will certainly teach a great deal. Diagnostic uncertainty 38.7% (39%) indicates a need for better training for clinical recognition of sepsis and serious bacterial infection syndromes. For Drug unavailability (21.3%) there is a systemic vulnerability in the pharmaceutical supply chain that needs interventions at the Ministry of Health level. Prescriber delay (24.2%) raises concerns about the lack of knowledge about time to antibiotic benchmarks, which can be addressed through structured continuing medical education. Patient or family refusal (15.8%) highlights the need for effective communication with patients and culturally appropriate health literacy initiatives in the Samarra community.

The 68.8% de-escalation rate for Group A indicates that use of wide empirical antibiotic therapy is not synonymous with unnecessary antibiotic use or the promotion of antibiotic resistance when combined with a culture and sensitivity-guided stewardship program. The principle — start early, de-escalate quickly — is the synthesis of conflicting clinical needs based on evidence and should be embedded as best practice in Samarra General Hospital. Some study limitations are associated with both retrospective and prospective data collection, such as inconsistencies associated with documentation. Results of this study may not be representative of rural or smaller district-level facilities in the Salah ad-Din Governorate as it is a single center study. Furthermore, the day-3 SOFA trajectory data, which are a more powerful predictor of

mortality, were not systematically obtained for all included patients, although they were collected at admission.

Conclusions and Recommendations

This cross-sectional study was conducted in Samarra General Hospital in 2025, offering strong clinical findings on the importance of timely antibiotic initiation during the critical window of bacterial infection as one of the most effective hospital life-saving procedures. But a saving and lowering of suffering is just as much a reality as a statistic: A mortality rate of 7.5% versus 36.7%, a complication rate of 17.1% versus 63.3%, and a mean hospital stay of 5.2 days versus 14.6 days — all in favor of the decisive-period treatment group.

The recommendations offered below are based on evidence and are offered for implementation at Samarra General Hospital and for consideration by Iraqi national health authorities:

- Implement a formal Sepsis and Bacterial Infection Early Alert Protocol to give antibiotics within 60 minutes of recognition of a Sepsis and within 3 hours of suspected serious bacterial infection in non-septic patients.
- Create a long-term Antimicrobial Stewardship Committee (ASC) of infectious disease physicians, clinical pharmacists, microbiologists, nursing leadership, and report quarterly prescribing audits, trends in antimicrobial resistance to hospital administration.
- Ensure the expense and purchase of new rapid diagnostic technologies such as MALDI TOF mass spectrometry and point of care procalcitonin assay, meticelling every effort to minimize time to pathogen identification and maximize accuracy of empirical antibiotic selection
- Use an updated institutional antibiogram, annually, and stratified by ward and source of infection to inform empirical prescribing practices in a way that reflects local resistance.
- Ensure that all Emergency Department and ward physicians, nurses and pharmacists participate in compulsory annual continuing medical education sessions on the concept of the decisive period, definition of sepsis and antibiotic de-escalation principles.
- Implement the National Essential Medicines List (NEM) in all Salah ad Din Governorate hospitals including the provision of essential antibiotic agents and emergency procurement plans in case of shortage.
- To create focused health literacy initiatives in Arabic for patients and family members in the Samarra area regarding the importance and use of antibiotics for severe infections.

The time of Samarra General Hospital – indeed, the time of every public hospital in Iraq – should be the norm rather than the exception. Every hour matters. Every dose counts.

Declarations

Ethics Approval and Consent to Participate: This study received approval from the Samarra General Hospital (SGH) Institutional Review Board (IRB) and the Research Ethics Committee (REC) with reference number SGH-IRB-2025-009 (8th January 2025). All patients or legal guardians, who were prospectively enrolled, gave informed consent. The patient data were accessed with a waiver of consent in line with the research guidelines of the Iraqi Ministry of Health.

Conflict of Interest: The authors have no financial, personal or professional conflicts of interest relating to this study.

Funding: This study was conducted as a part of the departmental clinical research and quality improvement project related to 2025 at Samarra General Hospital without any external funding.

M.T.A. conceived the study, supervised data collection and drafted the manuscript. Pharmacological analysis and stewardship review was done by N.K.H. S.A.A. conducted microbiological testing and statistical modelling. All authors reviewed and approved the final manuscript.

Data Availability: Deidentified data, supporting the conclusions of this article, are available from the corresponding author upon reasonable written request.

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