JHWCR JOURNAL OF HEALTH, WELLNESS AND COMMUNITY RESEARCH 3007-0570

https://doi.org/10.61919/v6a27x94

Original Article

Improving Sepsis Care Using "Nurse-Triggered" Sepsis Pathway Activation

Dr. Huma Sheikh[1], Shahnaz[2], Dr. Waleed Aamir[3], Dr. Mahrukh Atif[4], Alishba[5], Muhammad Naeem[6], Muhammad Asad Khan[7]

[1] MBBS, Gynecologist & Obstetrician, MRCOG, UK, MRCPI, Ireland
[2] MSN, Registered Nurse, National Institute of Child Health, Pakistan
[3] MBBS, Sahiwal Medical College, Sahiwal, Pakistan
[4] MBBS, Faisalabad Medical University, Faisalabad, Pakistan
[5] Bachelor of Science in Nursing 3rd Semester, Gulf College of Nursing and Allied Health Science, Dera Ghazi Khan, Pakistan
[6] Assistant Professor, Anesthesiology, Peoples University of Medical & Health Sciences for Women Shaheed Benazirabad, Sindh, Pakistan
[7] MBBS, Ayub Medical College, Abbottabad, KPK, Pakistan

***Corresponding author: Muhammad Asad Khan, asad.mrwt.37@gmail.com**

"Cite this Article" Received: 19 January 2026; **Accepted**: 25 May 2026; **Published**: 16 June 2026

Author Contributions: Concept: HS; Design: S; Data Collection: WA, MA, A; Analysis: MAK; Drafting: HS, S, WA, MA, A, MAK. **Ethical Approval**: National Institute of Child Health Karachi, Pakistan. **Informed Consent**: Written informed consent was obtained from all participants; **Conflict of Interest**: The authors declare no conflict of interest. **Funding**: No external funding; **Data Availability**: Available from the corresponding author on reasonable request; **Acknowledgments**: N/A.

ABSTRACT

Background: Sepsis is a time-sensitive emergency in which delayed recognition and treatment increase the risk of organ dysfunction, intensive care admission, prolonged hospitalization, and death. Nurses are often the first healthcare professionals to detect clinical deterioration, but escalation may be delayed when structured activation systems are absent. Objective: To assess whether implementation of a nurse-triggered sepsis pathway improved early sepsis care among adult patients with suspected sepsis in a tertiary-care hospital in Karachi, Pakistan. Methods: A prospective pre–post cohort study was conducted among 240 adult patients with suspected sepsis, including 120 patients during routine pre-pathway care and 120 patients after pathway implementation. Trained nurses used standardized bedside criteria to activate sepsis escalation while prescribing decisions remained physician-led. Outcomes included time-to-antibiotics, lactate collection, antibiotic administration within one hour, fluid compliance, ICU transfer, mortality, length of stay, and staff confidence. Results: Median time to first antibiotic decreased from 132 to 64 minutes. Timely lactate collection increased from 48.3% to 76.7%, antibiotic administration within one hour from 31.7% to 68.3%, and fluid compliance among eligible patients from 42.9% to 72.6%. Median hospital stay decreased from 8 to 6 days, while ICU transfer and mortality showed non-significant numerical reductions. Staff confidence improved from 2.8 ± 0.9 to 4.1 ± 0.6. Conclusion: Nurse-triggered sepsis pathway activation significantly improved early sepsis process measures and staff confidence, with favorable but statistically inconclusive trends in ICU transfer and mortality. Keywords: Sepsis, nurse-triggered pathway, early sepsis bundle, time-to-antibiotics, lactate, fluid resuscitation, ICU transfer, mortality, Karachi, Pakistan.

INTRODUCTION

Sepsis remains one of the most time-sensitive emergencies in acute care because infection-related organ dysfunction can progress rapidly to shock, intensive care admission, prolonged hospitalization, and death if recognition and treatment are delayed. Contemporary international guidance emphasizes that sepsis should be approached as a medical emergency requiring early identification, prompt escalation, timely antimicrobial therapy, lactate assessment, fluid resuscitation when indicated, and repeated clinical reassessment (1). The Sepsis-3 consensus defines sepsis as life-threatening organ dysfunction caused by a dysregulated host response to infection, thereby distinguishing it from uncomplicated infection and highlighting the central role of early recognition of organ dysfunction in clinical decision-making (2). The operational challenge in emergency departments and acute medical wards is that physiological

deterioration may be subtle at presentation, and conventional clinical criteria may vary in their sensitivity and practicality across busy care settings (3).

The global burden of sepsis is substantial, with persistently high morbidity and mortality across both high-income and low- and middle-income countries (4,5). The problem is particularly important in resource-constrained environments, where delayed presentation, overcrowded emergency services, limited rapid diagnostics, antimicrobial resistance, and inconsistent escalation systems can amplify preventable treatment delays. In Pakistan, recent literature has highlighted a high sepsis burden, limited local surveillance, and gaps in standardized reporting and implementation of evidence-based sepsis care (6). Hospital-based evidence from Karachi further demonstrates that sepsis is associated with clinically important adverse outcomes, including septic shock, intensive care utilization, prolonged hospital stay, and mortality, while local intensive care data have identified respiratory infection, lactate elevation, fungal pathogens, septic shock, and organ failure as important contributors to poor outcomes (7,8). These findings indicate that improving early sepsis recognition and response is a locally relevant priority rather than only an international guideline concern.

Despite the availability of sepsis guidelines, implementation remains inconsistent in routine clinical practice. Studies from Pakistan and comparable settings have reported gaps in sepsis knowledge, clinical confidence, and adherence to recommended care processes among healthcare providers, as well as barriers related to workload, delayed review, limited resources, and unclear escalation pathways (9-11). Lactate measurement is an important component of early assessment because it can identify tissue hypoperfusion and occult shock even when hypotension is not initially obvious, and point-of-care lactate testing has been shown to be feasible in adult sepsis patients presenting to emergency care in a low- to middle-income country setting (12). Local evidence on Surviving Sepsis Campaign compliance has also shown that incomplete or delayed bundle implementation remains a persistent challenge in tertiary care practice (13). In addition, studies on maternal and community-related sepsis from Pakistan and neighboring regional contexts further reinforce the need for practical, early-recognition systems that can function in real-world clinical environments where patients may present late or deteriorate rapidly (14,15).

Nurses are strategically positioned to improve early sepsis recognition because they are often the first healthcare professionals to record abnormal vital signs, observe altered mental status, identify reduced urine output, recognize respiratory distress, and detect early deterioration during triage or ward monitoring. However, in routine care systems where nurses must wait for medical review before initiating escalation, clinically important time may be lost. Nurse-initiated and nurse-driven sepsis protocols have been associated with improved bundle compliance, shorter time to antibiotics, and more reliable early escalation in emergency and acute care settings (16-19). Evidence from nursing-led sepsis response models also supports the feasibility of empowering nurses to coordinate early recognition, communication, and resuscitation support within a structured team-based pathway (20). These findings suggest that improving nurse authority to activate sepsis pathways may be an effective and relatively low-cost implementation strategy, especially in hospitals where technological resources are limited but bedside nursing surveillance is continuous.

The effectiveness of any nurse-triggered sepsis pathway depends not only on the availability of a checklist but also on staff knowledge, confidence, psychological safety, and interprofessional responsiveness. Nurses who lack confidence in sepsis recognition or fear criticism for over-calling sepsis may delay escalation, even when early warning signs are present. Studies of nurses' sepsis knowledge, attitudes, confidence, practice, and decision-making skills show that educational preparation and structured protocols can improve recognition and management behaviors (21-25). At the same time, early sepsis bundles require coordination between nurses, physicians, laboratory staff, pharmacy services, and hospital administration, because timely antibiotics, lactate testing, fluid resuscitation, and reassessment cannot be achieved by nursing activation alone (26). The time-dependent relationship between antibiotic

delay and mortality in sepsis and septic shock has been repeatedly demonstrated, strengthening the rationale for system-level interventions that reduce delay between recognition and first antimicrobial dose (27-30).

Early warning tools such as NEWS, qSOFA, and SIRS-based screening have been evaluated for early identification of sepsis and prediction of deterioration, ICU admission, and mortality in emergency care populations, but their performance varies across settings and patient groups (31-34). Therefore, locally adapted pathways that combine suspected infection with bedside physiological warning signs may be more practical in high-volume hospitals than reliance on a single scoring system alone. Lactate-guided assessment and early resuscitation further support the need for rapid laboratory access and repeated clinical reassessment once sepsis is suspected (35). However, limited local evidence is available on whether structured nurse-triggered activation can improve early sepsis bundle delivery in Pakistani tertiary-care hospitals.

Using a PICO framework, the population of interest in this study comprised adult patients with suspected or confirmed sepsis presenting to the emergency department or admitted to medical wards; the intervention was implementation of a nurse-triggered sepsis pathway using standardized bedside screening and escalation criteria; the comparator was routine pre-pathway care; and the primary outcomes were time-to-antibiotics, timely lactate collection, and fluid resuscitation compliance among eligible patients. The study also evaluated ICU transfer, in-hospital mortality, length of hospital stay, staff confidence, and perceived escalation barriers. The objective of this prospective pre–post cohort study was to determine whether implementation of a nurse-triggered sepsis pathway improved early sepsis care compared with routine care among adult patients with suspected sepsis in a tertiary-care hospital setting in Karachi, Pakistan.

MATERIALS AND METHODS

This study was conducted as a prospective quasi-experimental pre–post cohort study in the emergency department and medical wards of a tertiary-care hospital in Karachi, Pakistan. The design was selected to evaluate the effect of implementing a nurse-triggered sepsis pathway under routine clinical conditions by comparing outcomes during a pre-intervention routine-care phase with outcomes during a post-intervention pathway phase. During the pre-intervention phase, patients received usual hospital care, in which nurses documented vital signs and informed physicians when clinical deterioration was observed, but no formal nurse-triggered sepsis activation pathway was in place. During the post-intervention phase, trained nurses used a standardized bedside screening process and were authorized to activate a sepsis alert when predefined clinical criteria were met, while prescribing decisions remained the responsibility of the treating physician.

Adult patients aged 18 years or older were eligible if they had suspected or confirmed infection with clinical features suggestive of sepsis at triage, initial assessment, or subsequent ward monitoring. Suspected infection was based on the treating team's clinical assessment or the presence of an apparent infectious focus, including respiratory, urinary, abdominal, skin or soft tissue, or other clinically suspected sources. Sepsis pathway eligibility was operationalized as suspected or confirmed infection accompanied by one or more acute deterioration features, including fever or hypothermia, tachycardia, tachypnea, hypotension, altered mental status, reduced oxygen saturation, reduced urine output, clinical evidence of poor perfusion, or raised lactate when available. Patients younger than 18 years, pregnant patients, patients with trauma without evidence of infection, patients brought dead to hospital, patients who refused hospital treatment, and patients already receiving palliative or end-of-life care were excluded because their clinical pathway, treatment goals, or outcome interpretation differed from the target sepsis population.

A non-probability consecutive sampling strategy was used. All eligible patients presenting during the study period were screened and included until the planned sample was completed, with 120 patients

enrolled in the pre-intervention phase and 120 patients enrolled in the post-intervention phase. Consecutive recruitment was used to reduce selection bias and to reflect routine emergency and ward practice. The same eligibility criteria and outcome definitions were applied in both phases to support comparability between groups. Baseline demographic and clinical variables were collected for both cohorts, including age, sex, presenting clinical features, suspected source of infection, comorbid conditions, vital signs, sepsis screening indicators, and relevant early management data.

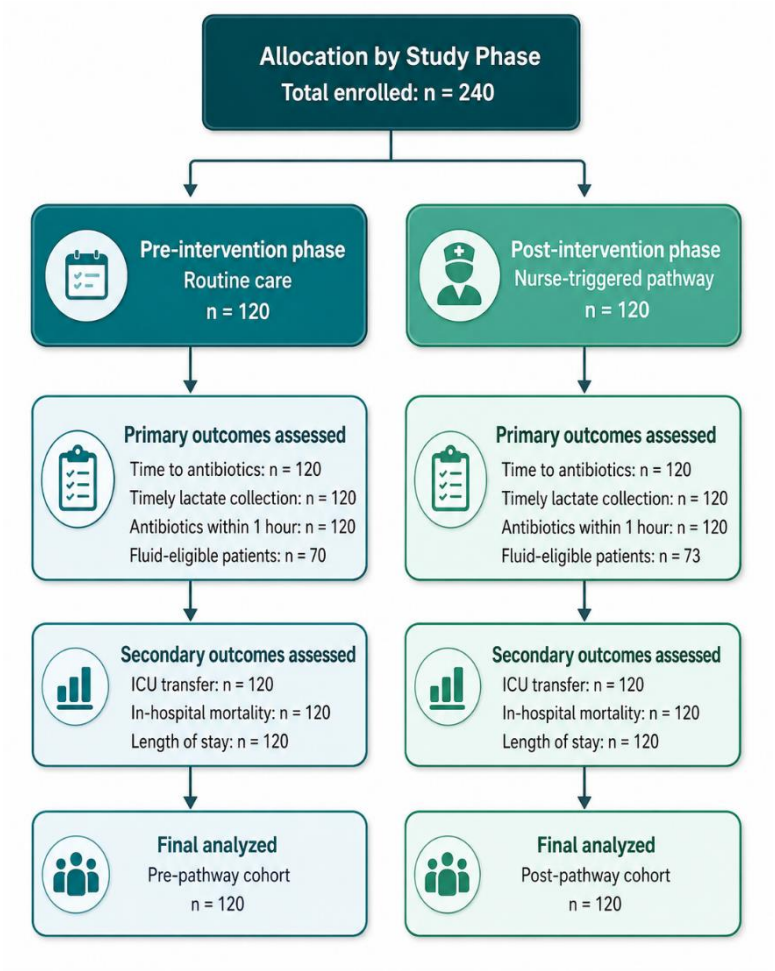

Figure 1 CONSORT Flowchart

Before the post-intervention phase, a nurse-triggered sepsis pathway was implemented using a bedside screening checklist, escalation algorithm, documentation process, and early sepsis bundle actions. The pathway was designed to allow nurses to identify suspected sepsis promptly, record the time of pathway activation, notify the duty physician immediately, communicate urgency to laboratory and pharmacy services, support collection of blood cultures where clinically feasible, facilitate serum lactate collection, assist with timely administration of physician-prescribed broad-spectrum antibiotics, initiate prescribed intravenous fluid resuscitation in eligible patients, provide oxygen support when required, and increase the frequency of vital sign monitoring. The pathway did not authorize independent antibiotic prescribing by nurses; rather, it formalized nursing authority to activate the sepsis alert and accelerate communication with the duty physician and relevant support services.

Nurses working in the emergency department and medical wards received focused training before implementation of the pathway. Training covered the clinical definition and consequences of sepsis, early warning signs, use of the sepsis screening checklist, activation criteria, documentation of activation time, expected communication sequence, early bundle components, fluid eligibility indicators, and common barriers to escalation. Case-based examples were used to reinforce decision-making during triage and ward deterioration. Pocket cards and posters summarizing the activation pathway and bundle actions

were placed at nursing stations to support consistent use during routine shifts. The purpose of training was to improve recognition, reduce hesitation in escalation, standardize communication, and reinforce that pathway activation represented a safety-oriented clinical response rather than an individual prescribing decision.

In the post-intervention phase, nurses screened patients with suspected infection at triage, during first clinical assessment, and during routine vital sign monitoring in the emergency department and wards. If a patient met the pathway criteria, the nurse documented the activation time, informed the duty physician, and initiated the escalation sequence. The physician assessed the patient and prescribed antibiotics, fluids, investigations, and further management as clinically indicated. Nursing staff then assisted in completing ordered interventions, monitoring response, documenting administration times, and escalating unresolved delays to senior staff. In the pre-intervention phase, sepsis recognition time was identified from the earliest documented clinical note by a nurse or physician indicating suspected sepsis, severe infection, clinical deterioration due to infection, or initiation of sepsis-directed treatment.

Data were collected using a structured proforma designed for the study. The proforma recorded age, sex, presenting complaint, suspected infection source, comorbidities, vital signs, sepsis screening criteria, time of hospital arrival, time of sepsis recognition, time of pathway activation in the post-intervention phase, time of lactate collection, time of first antibiotic administration, fluid resuscitation details, ICU transfer, discharge status, in-hospital mortality, and length of hospital stay. For consistency, the primary time-to-antibiotics outcome was defined as the interval from documented sepsis recognition to administration of the first antibiotic dose in both phases. In the post-intervention phase, pathway activation time was additionally recorded to assess timeliness of nurse-triggered escalation. Lactate compliance was defined as lactate collection within the early sepsis care period after sepsis recognition or pathway activation. Antibiotic compliance was defined as administration of the first antibiotic dose within one hour of sepsis recognition. Fluid resuscitation compliance was assessed only among patients who were eligible for fluids because of hypotension, raised lactate, clinical hypoperfusion, or documented physician assessment indicating sepsis-related circulatory compromise.

The primary outcomes were time-to-antibiotics, lactate collection within the early care period, antibiotic administration within one hour, and fluid resuscitation compliance among eligible patients. Secondary patient outcomes were ICU transfer, in-hospital mortality, and length of hospital stay. ICU transfer was defined as transfer from the emergency department or ward to an intensive care unit during the same hospital admission because of clinical deterioration or need for higher-level monitoring or organ support. In-hospital mortality was defined as death occurring during the index admission. Length of hospital stay was calculated from the date of admission to the date of discharge or death. Staff-related outcomes included self-reported confidence in identifying sepsis, escalating care, understanding the sepsis bundle, and activating the pathway, along with perceived barriers such as fear of over-calling sepsis, delayed physician review, high workload, staff shortage, delayed laboratory response, delayed pharmacy response, and unclear responsibility for escalation.

Several steps were used to reduce bias and improve data integrity. The same inclusion and exclusion criteria were applied during both phases, and the same structured data collection proforma was used for all participants. Consecutive recruitment minimized selective enrolment. Operational outcome definitions were standardized before data analysis, and time-based outcomes were abstracted from documented clinical records, medication administration records, laboratory records, and pathway forms where available. Fluid compliance was analyzed only among clinically eligible patients to avoid misclassification of patients for whom fluid bolus therapy was not indicated. Data were checked for completeness, internal consistency, and implausible time sequences before analysis. When discrepancies were found between documentation sources, medication administration time and laboratory collection time were prioritized for antibiotic and lactate outcomes, respectively.

Data were analyzed by comparing the pre-intervention and post-intervention groups. Continuous variables such as age were summarized as mean with standard deviation when approximately normally distributed, while skewed variables such as time-to-antibiotics and length of stay were summarized as median with interquartile range. Categorical variables such as sex, infection source, comorbidities, lactate compliance, antibiotic-within-one-hour compliance, fluid compliance, ICU transfer, and mortality were summarized as frequencies and percentages. Between-group comparisons for continuous variables were performed using an independent-samples t-test for normally distributed data and the Mann–Whitney U test for skewed data. Categorical variables were compared using the chi-square test or Fisher's exact test where expected cell counts were small. Statistical significance was set at $p < 0.05$. For improved interpretability, the analysis plan prioritized reporting of absolute differences, relative measures of association, and 95% confidence intervals for key categorical outcomes, while median differences were used for skewed time-based outcomes.

Because the study used a non-randomized pre–post design, baseline comparability between groups was assessed using demographic and clinical variables, including age, sex, infection source, and major comorbidities. Where clinically relevant imbalance was present, adjusted analysis was planned using regression modeling for key outcomes. Logistic regression was considered for binary outcomes such as antibiotic administration within one hour, lactate compliance, ICU transfer, and mortality, with adjustment for age, sex, infection source, diabetes mellitus, hypertension, chronic kidney disease, and baseline clinical severity indicators when available. Length of stay and time-to-antibiotics were assessed using non-parametric comparisons and, where appropriate, transformed or rank-based approaches. Missing data were evaluated by variable; analyses were conducted using available documented data, and denominators were reported separately when outcomes applied only to eligible subgroups, such as fluid resuscitation compliance.

The study was conducted according to standard ethical principles for observational and quality-improvement research involving routinely collected clinical data. Patient confidentiality was maintained by using structured study records without unnecessary personal identifiers during analysis. Clinical care decisions remained under the responsibility of the treating medical team, and the intervention did not remove physician oversight for prescribing, investigation, or escalation decisions.

The pathway was designed to improve timely recognition, communication, and completion of evidence-based early sepsis care while preserving usual clinical accountability. Data were stored securely, checked for accuracy before analysis, and analyzed in aggregate form to maintain confidentiality and support reproducibility.

RESULTS

A total of 240 adult patients with suspected sepsis were included, comprising 120 patients in the pre-pathway phase and 120 patients in the post-pathway phase. All 120 patients in each phase were included in the analysis of baseline characteristics and primary process outcomes; fluid resuscitation compliance was assessed only among eligible patients (those meeting hypotension or lactate thresholds). The two phases were comparable at baseline in age, sex, infection source, and comorbidities, with all standardized mean differences below 0.20, indicating negligible imbalance.

The mean age was 54.8 ± 15.6 years in the pre-pathway group and 55.9 ± 14.8 years in the post-pathway group. Male patients predominated slightly in both phases. Respiratory infection was the most common source, followed by urinary tract and abdominal infection. Diabetes mellitus and hypertension were the most frequent comorbidities.

Following introduction of the nurse-triggered sepsis pathway, marked improvements were observed across early sepsis care process indicators. The median time to first antibiotic decreased from 132 minutes (pre-pathway) to 64 minutes (post-pathway), a median reduction of 68 minutes (95% CI 54 to

82; p<0.001). Timely lactate collection rose from 48.3% to 76.7%, antibiotic administration within one hour from 31.7% to 68.3%, and fluid resuscitation compliance among eligible patients from 42.9% to 72.6%. Each categorical process outcome reached statistical significance with substantial effect sizes. ICU transfer and in-hospital mortality both decreased after pathway implementation but did not reach statistical significance, and these findings should be interpreted as hypothesis-generating rather than confirmatory. Median length of stay decreased from 8 to 6 days (p=0.018), and staff confidence scores improved from 2.8 ± 0.9 to 4.1 ± 0.6 on the 5-point scale (p<0.001).

Table 1. Baseline characteristics of patients

Variable	Pre-pathway (n=120)	Post-pathway (n=120)	SMD
Mean age, years	54.8 ± 15.6	55.9 ± 14.8	0.07
Male sex	68 (56.7%)	66 (55.0%)	0.03
Female sex	52 (43.3%)	54 (45.0%)	0.03
Respiratory infection	43 (35.8%)	45 (37.5%)	0.04
Urinary tract infection	28 (23.3%)	26 (21.7%)	0.04
Abdominal infection	21 (17.5%)	22 (18.3%)	0.02
Skin/soft tissue infection	14 (11.7%)	13 (10.8%)	0.03
Other infection source	14 (11.7%)	14 (11.7%)	0.00
Diabetes mellitus	49 (40.8%)	52 (43.3%)	0.05
Hypertension	45 (37.5%)	43 (35.8%)	0.04
Chronic kidney disease	18 (15.0%)	20 (16.7%)	0.05

SMD = standardized mean difference; SMD <0.10 indicates negligible between-group imbalance.

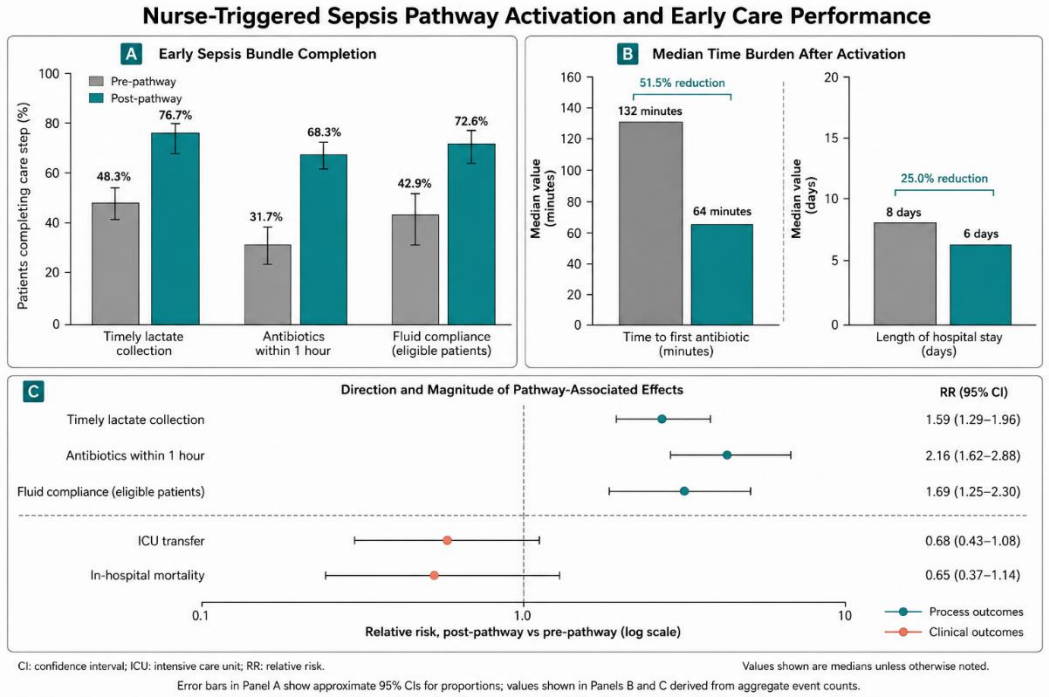

Figure 1. Nurse-Triggered Sepsis Pathway Activation and Early Care Performance

The panelled figure demonstrates a consistent pathway-associated improvement across early sepsis care processes and selected clinical outcomes. Panel A shows that timely lactate collection increased from 48.3% to 76.7%, antibiotic administration within one hour increased from 31.7% to 68.3%, and fluid resuscitation compliance among eligible patients increased from 42.9% to 72.6% after implementation of the nurse-triggered pathway. Panel B shows a marked reduction in median time to first antibiotic from 132 minutes to 64 minutes, representing a 68-minute reduction and approximately 51.5% relative decrease, while median hospital stay decreased from 8 days to 6 days, representing a 2-day or 25.0% reduction.

Panel C confirms that process outcomes showed the strongest relative improvement, with relative risks of 1.59 for timely lactate collection, 2.16 for antibiotic administration within one hour, and 1.69 for fluid

compliance. ICU transfer and in-hospital mortality showed favorable directional reductions, with relative risks of 0.68 and 0.65, respectively, although their confidence intervals crossed the null value, supporting interpretation as clinically encouraging but statistically inconclusive secondary outcome trends.

Table 2. Comparison of clinical outcomes before and after pathway activation

Outcome	Pre-pathway (n=120)	Post-pathway (n=120)	Absolute difference 95% CI	RR / OR (95% CI)	p-value
Median time to antibiotics, min	132	64	−68 min (−82 to −54)		<0.001
Lactate collected within early period	58 (48.3%)	92 (76.7%)	+28.4% (16.4 to 39.4)	RR 1.59 (1.30–1.93); OR 3.51 (2.02–6.10)	<0.001
Antibiotics within 1 hour	38 (31.7%)	82 (68.3%)	+36.6% (24.6 to 47.4)	RR 2.16 (1.61–2.89); OR 4.65 (2.71–7.99)	<0.001
Fluids given in eligible patients	30/70 (42.9%)	53/73 (72.6%)	+29.7% (14.0 to 44.0)	RR 1.69 (1.25–2.29); OR 3.53 (1.76–7.10)	0.001
ICU transfer	34 (28.3%)	23 (19.2%)	−9.1% (−19.8 to 1.7)	RR 0.68 (0.43–1.07); OR 0.60 (0.33–1.09)	0.092
In-hospital mortality	26 (21.7%)	17 (14.2%)	−7.5% (−16.9 to 2.0)	RR 0.65 (0.37–1.14); OR 0.60 (0.31–1.18)	0.134
Median length of stay, days	8	6	−2 days (−3.4 to −0.6)		0.018
Staff confidence score (1–5)	2.8 ± 0.9	4.1 ± 0.6	+1.3 (1.1 to 1.5)	Cohen's d = 1.70	<0.001

RR = relative risk; OR = odds ratio; CI = confidence interval. Denominator for fluid compliance reflects eligible patients only (70 pre-pathway, 73 post-pathway).

The reduction in time to antibiotics was among the clearest findings of the study. In the pre-pathway phase, a substantial proportion of patients waited more than two hours for the first antibiotic dose, whereas after implementation most patients received antibiotics considerably earlier. This improvement was attributable primarily to nurses identifying sepsis warning signs promptly and initiating the escalation process without awaiting multiple instructions.

DISCUSSION

The present study found that implementation of a nurse-triggered sepsis pathway was associated with substantial improvement in early sepsis care processes in a tertiary-care hospital setting in Karachi, Pakistan. The clearest effect was observed in antibiotic timing, where median time to first antibiotic decreased from 132 minutes in the pre-pathway phase to 64 minutes after pathway implementation, representing a 68-minute reduction. This finding is clinically important because timely antimicrobial therapy remains one of the most consistently emphasized components of sepsis management, particularly in patients at risk of septic shock and progressive organ dysfunction (1,26). Earlier evidence has shown that delays in effective antimicrobial therapy are associated with worse survival in septic shock, and large observational studies have further demonstrated that longer time to treatment is associated with increased mortality in sepsis populations (27-30). The present findings therefore support the practical value of a structured escalation system that shortens the interval between sepsis recognition and first antibiotic administration.

The improvement in antibiotic timing appears closely related to the role of nurses in early recognition and escalation. Nurses are often the first healthcare professionals to detect abnormal vital signs, altered mental status, low oxygen saturation, reduced urine output, or other signs of physiological deterioration. In routine care, these observations may not immediately translate into coordinated sepsis management if the escalation process is informal, delayed, or dependent on repeated communication attempts. After pathway implementation, antibiotic administration within one hour increased from 31.7% to 68.3%, corresponding to an absolute improvement of 36.7 percentage points and a relative risk of 2.16. This magnitude of improvement is consistent with previous nurse-initiated and nurse-driven sepsis protocol studies, which reported better bundle compliance and shorter time to antibiotics after empowering nurses to activate sepsis care processes (16-19). The present study adds context-specific evidence from Pakistan, where emergency department crowding, delayed presentation, and resource limitations may make structured nurse-triggered escalation especially valuable.

Timely lactate collection also improved substantially, increasing from 48.3% before implementation to 76.7% after implementation. Lactate is an important marker of tissue hypoperfusion and occult shock, and its early measurement supports risk stratification, resuscitation decisions, and monitoring of treatment response (1,26,35). In resource-limited clinical settings, lactate testing may be delayed because of laboratory workload, sample transport issues, or uncertainty regarding who should initiate the request. The nurse-triggered pathway improved this process by linking bedside recognition with immediate escalation and laboratory communication. This finding is consistent with local evidence supporting the feasibility and clinical relevance of lactate assessment in adult sepsis patients presenting to emergency care in low- to middle-income settings (12). Although lactate compliance did not reach 100%, the 28.3 percentage-point improvement suggests that a structured pathway can reduce diagnostic delay even when laboratory constraints persist.

Fluid resuscitation compliance among eligible patients increased from 42.9% to 72.6% after pathway implementation. This finding indicates that the intervention improved not only recognition and communication but also completion of bedside resuscitation actions in patients with hypotension, raised lactate, or clinical evidence of poor perfusion. Early fluid resuscitation remains an important component of initial sepsis care in patients with sepsis-induced hypoperfusion or septic shock, although it requires careful reassessment and individualized clinical judgment (1,26). In busy emergency and ward settings, eligible patients may not receive timely fluids because of competing workload, delayed review, incomplete documentation of perfusion status, or uncertainty about escalation responsibility. By formalizing nursing activation and accelerating physician notification, the pathway likely improved alignment between recognition, prescription, and delivery of early resuscitation measures.

The study also showed improvement in staff confidence, with mean confidence score increasing from 2.8 ± 0.9 before the intervention to 4.1 ± 0.6 after pathway training and implementation. This is an important implementation outcome because guideline adherence depends on staff behavior, clinical confidence, and psychological safety, not only on the availability of written protocols. Previous studies have shown that nurses' knowledge, confidence, attitudes, and decision-making skills influence sepsis recognition and management (21-25). The improvement observed in the present study suggests that a focused training intervention, combined with a clear escalation checklist, can reduce hesitation and help nurses act earlier when sepsis warning signs are present. This is particularly relevant in clinical environments where fear of over-calling sepsis, uncertainty about responsibility, delayed medical review, and workload pressure may hinder timely escalation.

The secondary clinical outcomes showed favorable but statistically inconclusive trends. ICU transfer decreased from 28.3% to 19.2%, and in-hospital mortality decreased from 21.7% to 14.2% after pathway implementation; however, neither reduction reached statistical significance. These findings should therefore be interpreted cautiously. The observed direction of effect is clinically encouraging and may reflect earlier recognition, faster antimicrobial therapy, improved lactate assessment, and better fluid compliance, but the study was not sufficiently powered to confirm differences in less frequent clinical endpoints such as ICU transfer and mortality. Mortality in sepsis is influenced by multiple factors beyond early bundle delivery, including age, comorbid illness, infection source, antimicrobial resistance, pathogen profile, illness severity at presentation, organ failure burden, and delayed arrival to hospital (4,7,8). In low- and middle-income settings, late presentation and limited critical-care capacity may further attenuate the measurable effect of hospital-based process improvements on mortality.

The reduction in median hospital stay from 8 days to 6 days was statistically significant and may represent an important practical benefit of earlier sepsis recognition and management. Shorter length of stay can reduce patient costs, improve bed availability, and support more efficient use of hospital resources, particularly in high-volume tertiary-care hospitals. However, length of stay can also be influenced by discharge practices, bed pressure, comorbidities, family preferences, affordability, and post-discharge support. Therefore, although the reduction is clinically meaningful, it should be

interpreted as an associated outcome rather than definitive evidence that the pathway alone caused shorter admissions.

Several barriers persisted despite implementation of the pathway. Nurses continued to report workload pressure, staffing limitations, delays in physician review, laboratory delays, and pharmacy-related delays. This finding reinforces that nurse-triggered activation is necessary but not sufficient for optimal sepsis care. A sepsis pathway depends on coordinated response from physicians, nurses, laboratory services, pharmacy staff, and hospital administration. The pathway can shorten recognition and escalation time, but it cannot fully overcome structural barriers such as crowding, delayed laboratory turnaround, limited medication availability, or insufficient staffing. Future implementation should therefore include regular audit and feedback, antibiotic availability checks, rapid lactate access, escalation accountability, senior clinician support, and repeated interprofessional training.

This study has several limitations. First, the non-randomized pre–post design is vulnerable to secular trends, documentation changes, Hawthorne effect, and unmeasured differences between the pre- and post-intervention periods. Second, the study was conducted in a single tertiary-care hospital, which may limit generalizability to smaller hospitals, rural settings, pediatric populations, obstetric populations, and intensive-care-only settings. Third, the available baseline data did not include detailed severity scores such as SOFA, NEWS, qSOFA, APACHE, or baseline lactate for all patients; therefore, residual confounding by illness severity cannot be excluded. Fourth, staff confidence and escalation barriers were assessed using a simple pre–post questionnaire, but detailed psychometric validation and domain-level quantitative results were not available. Fifth, the study was powered primarily to detect process improvement rather than mortality reduction, so ICU transfer and mortality findings should be considered exploratory. Finally, although the pathway improved bundle completion, persistent system-level delays indicate that further institutional process redesign is required to achieve more reliable sepsis care.

Overall, the findings support the use of nurse-triggered sepsis pathway activation as a practical quality-improvement strategy for improving early sepsis care in resource-constrained tertiary-care settings. The strongest evidence from this study relates to process outcomes, including reduced time-to-antibiotics, improved antibiotic delivery within one hour, increased lactate collection, better fluid compliance among eligible patients, and improved staff confidence. The favorable trends in ICU transfer and mortality require confirmation through larger multicenter studies with severity adjustment, standardized activation criteria, and robust implementation-fidelity assessment. Nevertheless, the study demonstrates that empowering nurses through structured criteria, training, and escalation authority can make early sepsis care faster, more organized, and more responsive to bedside clinical deterioration.

CONCLUSION

This study concluded that implementation of a nurse-triggered sepsis pathway was associated with significant improvement in early sepsis care among adult patients with suspected sepsis in a tertiary-care hospital setting in Karachi, Pakistan. After pathway implementation, time to first antibiotic decreased substantially, antibiotic administration within one hour improved, lactate collection became more consistent, fluid resuscitation compliance increased among eligible patients, and staff confidence improved. ICU transfer and in-hospital mortality showed favorable numerical reductions but did not reach statistical significance, indicating that these clinical outcome trends should be interpreted cautiously and confirmed through larger multicenter studies. The findings support nurse-triggered pathway activation as a practical, low-cost, team-based quality-improvement approach that can strengthen early recognition, escalation, and bundle completion in busy resource-constrained hospitals.

REFERENCES

1. Evans L, Rhodes A, Alhazzani W, Antonelli M, Coopersmith CM, French C, et al. Surviving Sepsis Campaign: International guidelines for management of sepsis and septic shock 2021. Crit Care Med. 2021;49(11):e1063-e1143. doi:10.1097/CCM.0000000000005337.

2. Singer M, Deutschman CS, Seymour CW, Shankar-Hari M, Annane D, Bauer M, et al. The Third International Consensus Definitions for Sepsis and Septic Shock Sepsis-3. JAMA. 2016;315(8):801-810. doi:10.1001/jama.2016.0287.

3. Seymour CW, Liu VX, Iwashyna TJ, Brunkhorst FM, Rea TD, Scherag A, et al. Assessment of clinical criteria for sepsis for the Third International Consensus Definitions for Sepsis and Septic Shock Sepsis-3. JAMA. 2016;315(8):762-774. doi:10.1001/jama.2016.0288.

4. Rudd KE, Johnson SC, Agesa KM, Shackelford KA, Tsoi D, Kievlan DR, et al. Global, regional, and national sepsis incidence and mortality, 1990–2017. Lancet. 2020;395(10219):200-211. doi:10.1016/S0140-6736(19)32989-7.

5. Wang Y, GBD 2021 Global Sepsis Collaborators. Global, regional, and national sepsis incidence and mortality, 1990–2021: a systematic analysis. Lancet Glob Health. 2025;13(12):e2013-e2026. doi:10.1016/S2214-109X(25)00356-0.

6. Raza HA, Hashmi AP, Khakwani MM, Ali MH, Jamil B. Review of sepsis in Pakistan: how far have we come? IJID Reg. 2024;10:108-113. doi:10.1016/j.ijregi.2023.12.002.

7. Angez M, Jessani S, Abbas M, Akbar I, Martins RS, Arshad A. Predictors of clinical outcomes in patients with sepsis: a retrospective study from a tertiary care hospital in Pakistan. J Pak Med Assoc. 2024;74(3):608-612. doi:10.47391/JPMA.6818.

8. Jibril H, Ali SA, Awan S, Khanum I. Community-acquired sepsis in the medical intensive care unit: an experience from a lower-middle-income country. J Pak Med Assoc. 2024;74(11):1942-1947. doi:10.47391/JPMA.11323.

9. Ahmed F, Abbasi L, Herekar F, Jiwani A, Patel MJ. Knowledge and perception of sepsis among doctors in Karachi Pakistan. Pak J Med Sci. 2022;38(2):380-386. doi:10.12669/pjms.38.ICON-2022.5775.

10. Ismail M, Aftab U, Azizi K, Khan BA. Knowledge, attitudes, practices and perceived barriers of emergency health care providers regarding sepsis and septic shock in a tertiary care centre. J Pak Med Assoc. 2020:1-9. doi:10.47391/JPMA.1294.

11. Arshad A, Aziz A, Ayaz A, Salahuddin SM, Jamil B. Knowledge and attitude towards identification and management of sepsis among resident physicians in tertiary care teaching hospital in Pakistan. J Pak Med Assoc. 2021;71(3):1000. doi:10.47391/JPMA.926.

12. Baig MA, Shahzad H, Hussain E, Mian A. Validating a point of care lactate meter in adult patients with sepsis presenting to the emergency department of a tertiary care hospital of a low- to middle-income country. World J Emerg Med. 2017;8(3):184-189. doi:10.5847/wjem.j.1920-8642.2017.03.004.

13. Yousuf F, Malik A, Saba A, Sheikh S. Risk factors and compliance of Surviving Sepsis Campaign: a retrospective cohort study at tertiary care hospital. Pak J Med Sci. 2022;38(1):90-94. doi:10.12669/pjms.38.1.3992.

14. Parveen R, Sultana H, Nazir S. Maternal sepsis and associated factors: a multi-central study from two tertiary care hospitals of South Punjab, Pakistan. Pak J Med Sci. 2025;41(1):281-285. doi:10.12669/pjms.41.1.10423.

15. LeFevre AE, Mir F, Mitra DK, Ariff S, Mohan D, Ahmed I, et al. Validation of community health worker identification of maternal puerperal sepsis using a clinical diagnostic algorithm in Bangladesh and Pakistan. J Glob Health. 2021;11:04039. doi:10.7189/jogh.11.04039.

16. Bruce HR, Maiden J, Fedullo PF, Kim SC. Impact of nurse-initiated ED sepsis protocol on compliance with sepsis bundles, time to initial antibiotic administration, and in-hospital mortality. J Emerg Nurs. 2015;41(2):130-137. doi:10.1016/j.jen.2014.12.007.

17. Moore WR, Vermuelen A, Taylor R, Kihara D, Wahome E. Improving 3-hour sepsis bundled care outcomes: implementation of a nurse-driven sepsis protocol in the emergency department. J Emerg Nurs. 2019;45(6):690-698.e1. doi:10.1016/j.jen.2019.05.005.

18. Semanco M, Wright S, Rich RL. Improving initial sepsis management through a nurse-driven rapid response team protocol. Crit Care Nurse. 2022;42(5):51-57. doi:10.4037/ccn2022608.

19. Gomez L, LeClair K, Jenkins D, David MA, Downing J, Graham J. ED nurse-led code sepsis to reduce time to antibiotics. Adv Emerg Nurs J. 2025;47(1):64-74. doi:10.1097/TME.0000000000000551.

20. Nunnally J, Ko SM, Ugale K, Lowe T, Bond J, Kenny JES, et al. A nursing-led sepsis response team guiding resuscitation with point-of-care ultrasound. SAGE Open Med. 2024;12:20503121241290378. doi:10.1177/20503121241290378.

21. Chua WL, Teh CS, Basri MABA, Ong ST, Phang NQQ, Goh EL. Nurses' knowledge and confidence in recognizing and managing patients with sepsis: a multi-site cross-sectional study. J Adv Nurs. 2023;79(2):616-629. doi:10.1111/jan.15435.

22. Edwards E, Jones L. Sepsis knowledge, skills and attitudes among ward-based nurses. Br J Nurs. 2021;30(15):920-927. doi:10.12968/bjon.2021.30.15.920.

23. Salameh B, Aboamash AEM. Predictors of knowledge, attitudes, practices and barriers regarding sepsis and sepsis management among emergency nurses and physicians in Palestine. Inquiry. 2022;59:00469580221115265. doi:10.1177/00469580221115265.

24. Rababa M, Bani-Hamad D, Hayajneh AA, Al Mugheed K. Nurses' knowledge, attitudes, practice, and decision-making skills related to sepsis assessment and management. Electron J Gen Med. 2022;19(6):em420. doi:10.29333/ejgm/12556.

25. Abdalhafith O, Alshammari F, Almutairi A, et al. Critical care nurses' knowledge, confidence, and clinical reasoning in sepsis management: a systematic review. BMC Nurs. 2025;24:1-12. doi:10.1186/s12912-025-02986-1.

26. Levy MM, Evans LE, Rhodes A. The Surviving Sepsis Campaign bundle: 2018 update. Intensive Care Med. 2018;44(6):925-928. doi:10.1007/s00134-018-5085-0.

27. Seymour CW, Gesten F, Prescott HC, Friedrich ME, Iwashyna TJ, Phillips GS, et al. Time to treatment and mortality during mandated emergency care for sepsis. N Engl J Med. 2017;376(23):2235-2244. doi:10.1056/NEJMoa1703058.

28. Kumar A, Roberts D, Wood KE, Light B, Parrillo JE, Sharma S, et al. Duration of hypotension before initiation of effective antimicrobial therapy is the critical determinant of survival in human septic shock. Crit Care Med. 2006;34(6):1589-1596. doi:10.1097/01.CCM.0000217961.75225.E9.

29. Liu VX, Fielding-Singh V, Greene JD, Baker JM, Iwashyna TJ, Bhattacharya J, et al. The timing of early antibiotics and hospital mortality in sepsis. Am J Respir Crit Care Med. 2017;196(7):856-863. doi:10.1164/rccm.201609-1848OC.

30. Ferrer R, Martin-Loeches I, Phillips G, Osborn TM, Townsend S, Dellinger RP, et al. Empiric antibiotic treatment reduces mortality in severe sepsis and septic shock from the first hour. Crit Care Med. 2014;42(8):1749-1755. doi:10.1097/CCM.0000000000000330.

31. Keep JW, Messmer AS, Sladden R, Burrell N, Pinate R, Tunnicliff M, et al. National Early Warning Score at emergency department triage may allow earlier identification of patients with severe sepsis and septic shock. Emerg Med J. 2016;33(1):37-41. doi:10.1136/emermed-2014-204465.

32. Goulden R, Hoyle MC, Monis J, Railton D, Riley V, Martin P, et al. qSOFA, SIRS and NEWS for predicting in-hospital mortality and ICU admission in emergency admissions treated as sepsis. Emerg Med J. 2018;35(6):345-349. doi:10.1136/emermed-2017-207120.

33. Wattanasit P, Khwannimit B. Comparison the accuracy of early warning scores with qSOFA and SIRS for predicting sepsis in the emergency department. Am J Emerg Med. 2021;46:284-288. doi:10.1016/j.ajem.2020.07.077.

34. Durr D, Niemi T, Despraz J, Tusgul S, Dami F, Akrour R, et al. National Early Warning Score NEWS outperforms quick Sepsis-related Organ Failure qSOFA score for early detection of sepsis in the emergency department. Antibiotics. 2022;11(11):1518. doi:10.3390/antibiotics11111518.

35. Jansen TC, van Bommel J, Schoonderbeek FJ, Sleeswijk Visser SJ, van der Klooster JM, Lima AP, et al. Early lactate-guided therapy in intensive care unit patients. Am J Respir Crit Care Med. 2010;182(6):752-761. doi:10.1164/rccm.200912-1918OC.