

Review

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Posted Date: 7 January 2026

doi: 10.20944/preprints202601.0435.v1

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Review

Adapting the Sepsis 1-Hour Bundle for Resource-Limited Settings: Lessons from Turkana, Kenya

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Abstract

The Surviving Sepsis Campaign (SSC) 1-hour bundle has transformed sepsis care in high-income countries. This bundle comprises rapid lactate measurements, blood cultures, broad-spectrum antibiotics, intravenous fluids, and vasopressors. However, in fragile systems such as Turkana County, Kenya, this protocol is largely impractical. This review synthesises current global and regional literature to contextualise the bundle's limitations and propose evidence-based adaptations. Long travel distances, shortage of essential diagnostics and medicine, limited human resources, and inadequate critical care capacity remain significant systemic barriers. This review advocates for reframing the bundle from a fixed 1-hour metric to an "as soon as possible" (ASAP) framework, emphasising early recognition, timely empirical antibiotics, and pragmatic hemodynamic stabilisation using available resources. Key recommendations include replacing lactate measurements with clinical surrogates (such as capillary refill time), creating locally informed empirical antibiotic protocols, strengthening supply chains, investing in task-sharing and simulation-based training, and embedding community awareness initiatives. These adaptations can achieve meaningful mortality reduction and mitigate antimicrobial resistance.

Keywords: sepsis; 1-hour bundle; antimicrobial resistance; resource-limited settings; global health; Turkana County; health systems strengthening; ASAP framework

1. Introduction

Sepsis is a leading cause of preventable mortality [1]. Sub-Saharan Africa has the heaviest burden of sepsis-related mortalities [2]. The SSC 1-hour bundle was introduced in 2018 and mandates the following actions within 60 minutes of sepsis recognition: measuring lactate, obtaining blood cultures, administering broad-spectrum antibiotics, delivering fluid resuscitation, and starting vasopressors for persistent hypotension [3]. This approach has significantly improved outcomes in well-resourced intensive-care units. However, in low- and middle-income countries (LMICs), implementation is constrained by geography, limited laboratory capacity, intermittent electricity, and severe workforce shortages [4,5]. In semi-arid and pastoral regions like Turkana County, in northwestern Kenya, the 1-hour bundle remains aspirational rather than achievable due to these constraints. This review examines the feasibility of each bundle component and outlines an adaptable, evidence-based framework relevant to similar contexts.

2. Methods

A focused narrative review was conducted between August 2024 and June 2025 using PubMed, Scopus, and African Index Medicus using the following Boolean search terms: ("sepsis bundle" OR "sepsis management") AND ("resource-limited" OR "low-income") AND ("Africa" OR "Kenya" OR "adaptation"). Publications from 2012 to 2025 were screened for relevance to sepsis management, health system capacity, and antimicrobial stewardship in resource-limited environments. The initial search yielded 284 articles. After screening titles and abstracts for direct relevance to the thematic

focus, 65 full-text articles were assessed, of which 38 were included in the final synthesis. Guidelines from the WHO, the 2021 update of SSC, and the 2021 consensus on Essential Emergency and Critical Care were reviewed. Evidence was synthesised thematically around diagnostic, therapeutic, human-resource, and systemic constraints.

3. Contextualising Sepsis Care in Turkana

Turkana is one of Kenya's poorest and remotest counties. It has a doctor-to-population ratio of about 1:90,000, and health facilities often lack diagnostic and therapeutic resources [6]. Inadequate sanitation, high temperatures, and widespread malnutrition increase the risk of infection [7]. Additionally, most patients present late after self-medication or use of traditional herbs, limiting the effectiveness of time-sensitive interventions, such as the 1-hour bundle. Blood cultures and lactate assays are rarely available outside the only referral facility. These stark realities necessitate adapting the global sepsis bundle into a pragmatic and context-applicable model that is responsive to disease profiles and local constraints.

4. Evidence from Sub-Saharan Africa

Emerging studies from African settings have demonstrated the need for localised sepsis definitions, triage tools, and management algorithms. A multicentre Ugandan study showed that simplified early warning scores and clinical assessment outperformed laboratory markers in predicting sepsis outcomes in resource-limited settings [8]. Moreover, a retrospective cohort analysis in Kenya showed that delayed antibiotic initiation beyond three hours increased mortalities by 27% among septic patients [9]. In contrast, aggressive fluid resuscitation of 30mL/kg, as recommended by the SCC guideline, has been linked with increased mortality in African adults with sepsis and limited access to mechanical ventilation [10]. Thus, these findings underscore the significance of tailoring fluid resuscitation volumes and antibiotic initiation timelines to the local epidemiology and resource base.

5. Challenges in Applying the 1-Hour Bundle

In most LMIC hospitals, adhering to the strict SSC 1-hour timeline remains unrealistic due to delays in triage, diagnostic testing, and drug administration [11]. In Turkana, health centres are staffed by nurses and clinical officers who manage acutely ill patients without immediate physician input. Constrained laboratory and pharmacy integration further hinders the completion of the bundle. For example, obtaining a lactate measurement or blood culture is entirely unavailable [12]. Inadequate local antibiograms and the rising prevalence of antimicrobial resistance often complicate empirical antibiotic selection [13]. In such scenarios, the reliance on global guidelines in the absence of contextual adaptation risks overuse of broad-spectrum antibiotics, culminating in AMR and poor patient outcomes [14].

6. Diagnostic Constraints and Clinical Judgement

Clinical acumen plays a crucial role in recognising sepsis in resource-limited settings. Laboratory markers such as procalcitonin or lactate are rarely accessible. Thus, bedside parameters such as temperature, respiratory rate, heart rate, and blood pressure are heavily relied upon. Studies in Malawi and Tanzania have validated modified sepsis recognition tools (quick Sequential Organ Failure Assessment (qSOFA)) as feasible screening alternatives [15]. Nevertheless, even qSOFA may underestimate sepsis severity in populations with high baseline tachypnea and anaemia [16]. Thus, integrating simplified triage tools, such as the South African Triage Scale (SATS) or locally adapted sepsis checklists, into primary care workflows could promote recognition and expedite intervention.

7. Fluid Resuscitation Dilemmas

The SSC recommends the rapid administration of 30 mL/kg of crystalloid fluids for hypotension or a lactate level ≥ 4 mmol/L [5]. Nonetheless, this approach has been challenged by trials in the African population where aggressive fluid resuscitation led to increased mortality, especially among patients with limited access to advanced monitoring and ventilatory support [17]. The FEAT trial, conducted in Uganda, Kenya, and Tanzania, revealed a 45% increase in mortality among children who received fluid boluses compared to those who received maintenance fluids [18]. Therefore, a conservative goal-directed approach emphasising frequent reassessment and judicious use of crystalloid is recommended for LMIC contexts [19]. In Turkana, fluid therapy should be guided by clinical endpoints rather than laboratory-guided metrics.

8. Antimicrobial Stewardship and AMR Implications

The global emphasis on early broad-spectrum antibiotic therapy within 1 hour of suspected sepsis poses unique challenges in settings with limited microbiology services. In Kenya, widespread empirical use of third-generation cephalosporins and carbapenems has contributed to the emergence of multidrug-resistant pathogens [20]. In Turkana, where culture facilities are absent, the empirical antibiotic policy must strike a balance between prompt coverage and stewardship principles. A tiered antibiotic protocol based on likely infection source, patient age, and comorbidities can optimise antimicrobial use while mitigating resistance risks.

9. Workforce and Systemic Barriers

Human resource shortages remain the principal constraint in implementing structured sepsis protocols. Most primary care facilities in Turkana operate with minimal staff, and high turnover is a result of the harsh living conditions. To bridge this gap, low-cost, high-frequency sepsis training, prompt telemedicine consultation with referral hospitals, and a simplified checklist could help address this issue [21]. Infrastructural inadequacies further impede rapid care. The integration of point-of-care diagnostics, portable ultrasound, and digital triage systems could enhance the early recognition and stabilisation of septic patients even in remote facilities [22].

The ASAP framework: A pragmatic model for sepsis care in resource-limited settings

A simplified, tiered model is essential to operationalise the sepsis 1-hour bundle in settings such as Turkana. The proposed ASAP framework (Assess, Stabilise, Administer, and Prioritise) provides a structured and adaptive approach to varying facility capacities.

- **Assess** emphasises prompt clinical recognition using locally validated triage protocols such as qSOFA or simplified early warning signs.
- **Stabilise** the airway, breathing, and circulation management with readily available resources; oxygen, isotonic fluids, and early patient positioning.
- **Administer:** mandates the prompt administration of the first dose of empirical antibiotics, directed by a locally developed, tiered protocol.
- **Prioritise** underscores the importance of dynamic reassessment, referral decision-making, and integration with higher-level care when feasible. This model bridges the gap between international standards and local realities while preserving the core intent of early intervention.

This model is operationalised through a tiered system of care (Table 1), ensuring accountability and scalability within the county health system.

At level 2 and 3 facilities, where diagnostic support is minimal, the focus should be on early recognition, prompt antibiotic initiation, conservative fluid management, and stabilisation for referral. Level 4 and 5 facilities should incorporate blood cultures, lactate monitoring, and targeted antimicrobial therapy aligned with resistance surveillance data. The tiered model facilitates scalability and accountability within county health systems while promoting continuity of care.

Implementation strategy and evaluation metrics

Multi-sectoral coordination and contextual flexibility are critical in the effective implementation of adapted sepsis protocols in resource-limited settings. The Kenyan Ministry of Health's Universal Coverage framework and the 2023 National Policy on Emergency and Critical Care offer policy entry points for integrating sepsis care into routine clinical governance. To ensure consistent adherence to protocols and facilitation of real-time audits, we must establish county-level Sepsis Response Teams, comprising senior clinicians and pharmacists.

Monitoring and evaluation must employ feasible metrics (Table 2). Data can be collected using simplified registers or mobile health tools for routine performance tracking [23]. In Turkana, such digital systems have already demonstrated success in tuberculosis and maternal health surveillance and could be repurposed for sepsis monitoring.

Low-cost training modules, bedside checklists, and mentorship programs significantly improved early recognition and reduced in-hospital mortality [24]. Training nurses and clinical officers in sepsis recognition and resuscitation has yielded promising outcomes, particularly in areas where physicians are scarce [25]. Incorporating sepsis education into continuous professional development frameworks ensures sustainability and quality improvements.

Sepsis and antimicrobial resistance

The intersection of sepsis management and antimicrobial resistance (AMR) forms a critical policy frontier. The World Health Organisation's Global Action Plan on AMR emphasises rational antibiotic use and diagnostic stewardship as key strategies [26]. However, in regions like Turkana, empirical antibiotic administration often precedes diagnosis due to a lack of laboratory confirmation. Integrating AMR surveillance into sepsis programs is crucial. Hospitals can establish basic culture-sensitivity panels through referral partnerships, whereas county-level health authorities maintain antibiograms to guide empiric therapy. Strengthening supply chain reliability to ensure timely access to narrow-spectrum antibiotics would further support stewardship goals.

A policy-relevant adaptation of the SCC bundle should align with Kenya's AMR National Action Plan (2023-2027), which advocates for evidence-based antimicrobial use and capacity building in rural health systems. A balanced approach—early empiric therapy followed by de-escalation once the infection source or resistance pattern is known—could mitigate resistance spread without compromising patient survival.

Health system strengthening and sustainability

Sustaining adapted sepsis care models demands alignment with existing health system frameworks. Integrating sepsis into national emergency care algorithms, essential medicine lists, and clinical audit structures can institutionalise best practices [27]. Partnerships between public health authorities, NGOs, and academic institutions could fund training, equipment and research initiatives. Additionally, establishing regional sepsis registries would generate longitudinal data for continuous quality improvement.

More importantly, investment in diagnostic infrastructure, workforce training and referral networks must be prioritised. The modest improvements in sepsis recognition and antibiotic timing can yield substantial survival gains at low cost per life-year saved [28]. In Turkana, where transport barriers delay referrals, community health workers could be trained to recognise the early signs of infection and initiate rapid facility linkage, forming the first tier of sepsis prevention.

Equity and global health implications

Contextual adaptation of the sepsis 1-hour bundle exemplifies the global health principle that equity demands flexibility. The application of a rigid protocol developed for tertiary hospitals in high-income countries risks widening disparities. To enhance effectiveness and fairness, pragmatic adaptations anchored in local realities must be adopted. Lessons from Turkana underscore the importance of integrating sepsis care into primary healthcare systems, rather than relying solely on critical care units.

Additionally, addressing sepsis in LMICs intersects with the global Sustainable Development Goals (SDGs). Ensuring access to timely antibiotics, adequate fluids, and skilled health workers represents a tangible pathway toward these objectives [29]. As global partners renew commitment to

pandemic preparedness and universal health coverage, sepsis care must remain central to these discussions.

10. Conclusions

The Sepsis 1-Hour bundle has transformed outcomes in well-resourced hospitals. However, its direct transfer to low-resource settings, such as Turkana, is neither feasible nor sustainable without contextual adaptation. The proposed ASAP Framework offers a pragmatic pathway that respects system constraints equally. Integrating sepsis protocols into national health policies, strengthening diagnostic capacity, and embedding antimicrobial stewardship at all levels will promote equitable and effective sepsis care. The global community must recognise that achieving timely sepsis management everywhere is a holistic imperative.

11. Key Messages

- 1. The Sepsis-1 Hour Bundle requires contextual adaptation for LMICs to ensure feasibility and sustainability.
- 2. The ASAP Framework (Assess, Stabilise, Administer, Prioritise) provides a scalable model for sepsis care across facility tiers.
- 3. Integrating sepsis care within national health systems can enhance equity and have a long-term impact.
- 4. Antimicrobial stewardship is crucial for balancing the need for rapid treatment with the mitigation of resistance.
- 5. Sepsis adaptation aligns with global health equity and universal health coverage goals.

Author Contributions: Omullo FP: Conceptualisation, administration, supervision, writing – original draft, writing – review and editing. The author has read and approved the final version of the manuscript.

Funding: The author received no financial support for the research, authorship, and/or publication of this article.

Informed Consent Statement: Informed consent was not required for this study.

Data: Availability Statement: Data sharing does not apply to this article as no data were created or analysed in this study.

Acknowledgments: None.

Conflicts of Interest: The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Disclosures: None.

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