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**Improving sepsis screening and care in a developing nation health setting: a  
description of implementation**

**Running title: Improving sepsis screening in a developing nation**

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## **CONFLICT OF INTEREST**

No conflict of interest has been declared by the authors.

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# **Improving sepsis screening and care in a developing nation health setting: a description of implementation**

**Running title: Implementation of sepsis screening and care**

## **Abstract**

Evidence on sepsis screening and care in developing nations is insufficient to inform implementation practices in hospital wards. The aim of this multi-method study was to describe and evaluate the implementation of a three-step intervention (sepsis screening, alert activation, care) in five wards in Argentina in 2017. The implementation involved three stages: 1) context assessment, 2) development/participation in implementation strategies, 3) evaluation of intervention adherence. Results were variable. The context assessment (Stage 1) demonstrated the value of education, proactivity towards care and team structures. Strategies developed (Stage 2) included sepsis screening and response guide, education, team rounding, posters, champions, audit/feedback and knowledge brokering. In Stage 3, staff screened 92% patients (506/547) for sepsis at  $\geq 60\%$  of set times; only 33% (21/64) patients had a sepsis alert activated when needed. A similar proportion of patients who had alerts activated (n = 16, 76%) or not (n = 32, 74%) received at least one element of care. The use of implementation strategies resulted in adherence to some aspects of the intervention. Future research is needed to improve sepsis screening, alert activation and care in this setting.

## **Key words**

Implementation strategies, sepsis screening, alert, care, hospital wards, developing nation

## Key points

- Little is known about the implementation of sepsis screening, alert activation and care in hospital wards in developing nation health settings.
- Rigorous context assessment was used to develop implementation strategies including written and verbal information, team rounding, champions, knowledge brokering, audit and feedback and visual reminders.
- The use of implementation strategies tailored to the setting resulted in good adherence ( $\geq 60\%$ ) to the screening procedures, and elements of sepsis care (76%), but were less helpful for activating the sepsis alert (33%). More research is needed to understand these differences.

## **1 INTRODUCTION**

Sepsis is a major cause of mortality and morbidity, and a World Health Organization recognized global concern (Reinhart et al., 2017). Of the 49 million people affected every year, 11 million will die (Rudd et al., 2020) and survivors may suffer lasting physical, mental and cognitive consequences (Prescott & Angus, 2018). Various reasons may contribute to these poor outcomes. First, the initial signs of sepsis can be subtle and nonspecific, and triggered by complex cellular changes (Abraham & Singer, 2007), which are difficult to recognise before organ damage is clinically evident. Second, age and comorbidities in survivors may contribute to a slower recovery and increased mortality in the post-acute period (Shankar-Hari, Harrison, Ferrando-Vivas, Rubenfeld, & Rowan, 2019), increasing the burden to patients, health systems and society. Third, resources such as technology to diagnose and treat sepsis, and staffing levels can influence patient outcomes. Although well-resourced health settings may experience challenges in diagnosing and treating sepsis (Heldens et al., 2018), adequate sepsis care is likely to be more difficult to achieve in health settings with fewer resources and may result in poor patient outcomes (Machado & Azevedo, 2018; Schultz et al., 2017). Therefore, understanding how sepsis screening, alert activation and care is implemented in less-resourced settings could help inform future quality improvement initiatives.

### **1.1 Literature review**

Over the past two decades, the surviving sepsis campaign (SSC) has provided evidence-based guidelines for the diagnosis and treatment of sepsis (Rhodes et al., 2017). Essentials of treatment of sepsis provided in the guidelines are known as the 6-h bundle and consist of obtaining cultures, administering antibiotics, measuring lactate,

administering fluids and vasopressors (Rhodes et al., 2017). Their use has been associated with a decreased sepsis mortality; the higher the adherence to the guidelines the better the patient outcomes (Chamberlain, Willis, & Bersten, 2011; Levy et al., 2012; Levy et al., 2014). However, sepsis care guidelines were predominantly applied in the developed world with limited evidence available about their implementation in developing countries where it is likely most of the global burden of sepsis resides (Finfer & Machado, 2016; Machado & Azevedo, 2018).

Studies conducted across different developing settings provide variable information about implementation of guidelines. For example, in Zambia, poor outcomes for the intervention group were reported following the introduction of a fluid resuscitation protocol (fluids and vasopressors) in hypotensive adults with sepsis (Andrews et al., 2017). In this study there was a dedicated study nurse to provide additional monitoring and authors acknowledged this level of care exceeded routine care practices (Andrews et al., 2017). Another study that implemented sepsis bundle elements, one of the largest SSC reports from the Americas and Europe, concluded that more compliant sites had a significant reduction in mortality, with South American sites found to be among the least compliant (Levy et al., 2014). Compliance was defined as: evidence that all bundle elements were applied within the expected time' (e.g. 6-h for the resuscitation bundle) with adherence <15% below the median of all sites defined as a low compliance (Levy et al., 2014). However, specific reasons for low compliance were not investigated and details of intervention implementation were not reported. In Asia, an international cohort study in 150 intensive care units (ICUs) across 16 countries, 64% which were in low- and middle-income nations, concluded that ICUs in wealthier countries demonstrated greater compliance to sepsis guidelines and had

significantly lower mortality when compared to ICUs in less wealthy countries (Phua et al., 2011). A higher proportion of ICUs with limited or no intensivist support, or nurse:patient ratios greater than 1:3, demonstrated lower compliance to the sepsis guidelines (Phua et al., 2011). While reasons for low adherence to the guidelines are not yet well understood, this evidence suggests translation of guidelines in developing nations can be problematic, possibly due to contextual factors such as limited staffing which may hamper guideline adherence.

The hospital ward population is vulnerable to sepsis; early signs of sepsis must be screened and identified to enable treatment guidelines to be implemented. The implementation of screening procedures is not an easy task. Even so, a systematic review of studies investigating screening tools for the early recognition of sepsis in the hospital ward population highlighted that the process of implementation of screening tools was rarely reported (Alberto, Marshall, Walker, & Aitken, 2017). Similar results were found by authors of a review focused on studies from sub-Saharan Africa (Morton, Stolbrink, Kagima, Rylance, & Mortimer, 2018). Researchers concluded there was a need to study context-sensitive tools to track patients at risk of sepsis and effective strategies to improve sepsis care (Morton et al., 2018). In summary, there is limited understanding about the implementation of sepsis screening tools and the subsequent provision of sepsis care.

Screening for sepsis and the provision of associated treatment requires clear implementation strategies to improve this complex clinical process. There are a range of different implementation strategies which have been described in the literature (Powell et al., 2015) and it is important that strategies are contextually specific (Waltz, Powell, Fernandez, Abadie, & Damschroder, 2019). There is little known about strategies to

implement sepsis screening and care; such information may help clinicians with future quality improvement initiatives in this area.

## **1.2 Aim**

The aim of this study was to describe and evaluate the implementation of a three-step intervention to improve sepsis screening, alert activation and care in five hospital wards of a tertiary referral hospital in Argentina, a developing nation according to the United Nations (United Nations, 2018). The intervention comprised the quick Sequential [Sepsis-Related] Organ Failure Assessment (qSOFA)-based sepsis screening (SS) tool, the activation of a sepsis alert, and implementation of the Surviving Sepsis Campaign (SSC) 6-hour (6-h) bundle.

## **2 METHODS**

### **2.1 Study design**

A multi-methods design was used to describe and evaluate the implementation of a three-step intervention to improve sepsis screening, alert activation, and care. This study was part of a larger project to test the diagnostic accuracy of the qSOFA-based SS tool and the benefits of its use (Alberto, Aitken, Walker, Palizas, & Marshall, 2020). Ethics approval was granted by Griffith University Human Research Ethics Committee (GU Ref No: 2016/805) and relevant Institutional Review Boards in the local setting. This article is reported using SQUIRE guidelines (Ogrinc et al., 2016) (Supplementary File 1).

### **2.2 Theoretical framework**

The theoretical underpinning for this study was the Promoting Action on Research Implementation in Health Services (PARiHS) framework. This framework has

been developed to help understand the process of change by conceptualising three elements: evidence, context and facilitation which have been identified as being necessary for successful implementation (Rycroft-Malone et al., 2002). According to PARiHS, evidence is derived from research and includes how the experience of clinicians, patients and setting play a role in adjusting the evidence (Rycroft-Malone et al., 2004). Context refers to the setting where the practice change will be implemented (Mekki et al., 2017), as well as the existing human relationships. Facilitation includes procedures, embodied skills and attributes that enable individuals, teams and organizations to use the proposed evidence (Cranley, Cummings, Profetto-McGrath, Toth, & Estabrooks, 2017). This element can be viewed as an individual role or as a process involving groups and an interactive problem-solving strategy.

### **2.3 Intervention**

The three-step intervention for this study was informed by available evidence and comprised the screening tool, which incorporated the qSOFA together with the presence of confirmed or suspected source of infection (qSOFA-based SS tool), the activation of a sepsis alert, and implementation of the 6-h bundle (Alberto et al., 2020; Singer et al., 2016; Surviving Sepsis Campaign Executive Committee, 2015). The 6-h bundle included measurement of lactate level, obtention of cultures, administration of antibiotics, fluids, and vasopressors (Surviving Sepsis Campaign Executive Committee, 2015). The intervention was tailored to the setting by incorporating feedback from clinicians. This included staff input into decisions on the screening process (e.g. frequency of screening, documentation format), alert activation (e.g. mechanism to activate the alert) and reviewing availability of resources to comply with the 6h-bundle.

Nurses were asked to screen for sepsis using the qSOFA-based SS tool at the time they would normally assess patient vital signs, and report to the physician-in-charge if the qSOFA score was  $\geq 2$  points and there was confirmed, or suspected infection (Alberto et al., 2020). When reporting to physicians, nurses were instructed to inform them that the screening criteria were met, which meant the patient needed medical review. This procedure was the activation of the sepsis alert; physicians provided 6-h bundle care if needed.

Implementation of the intervention was led by a team consisting of nurse and physician leaders and the researchers. The implementation involved three stages: (1) context assessment, (2) development of and participation in implementation strategies, and (3) evaluation of intervention adherence (Figure 1). Briefly, context assessment data were used to inform the development of implementation strategies which focused on information dissemination, initial and ongoing education, and audit with feedback. Implementation strategies were applied with different levels of staff participation. After disseminating information and initial education, the intervention was live, ongoing education was provided, audit and feedback were conducted, and intervention adherence was evaluated. Data collection, analysis and results sections provide more details of these three stages.

## **2.4 Setting**

Five medical-surgical wards in a 169-bed tertiary private hospital in Buenos Aires represented the setting. The participating wards were staffed by 150 clinicians, including nurses and physicians, and admitted complex medical and surgical patients across a range of speciality areas. Patient clinical information was available in paper-based (vital signs, medication and fluid orders) and electronic health records (routine

reviews, planned and provided treatment and pathology reports). The nurse:patient ratio was 1:5 to 1:6 and nurses worked fixed shifts (e.g. days only or nights only). During normal operating hours medical staff within each ward included 1 to 2 internal medicine specialists and 1 to 6 residents, depending on ward size. Out of hours, 3 to 4 residents were available to cover all wards, with consultants being on-call. All professionals accessed the electronic health record via shared computers in each ward. Despite being unable to provide specific funding to the study, the site authority acknowledged the need for implementing a sepsis screening and care initiative and fully supported the study helping to identify the available resources.

## **2.5 Sample**

Stage 1 involved context assessment and included 46 physicians and 104 nursing staff in the five study wards. In stage 2, the intervention was introduced to staff from each of the study wards using a range of implementation strategies. For the last stage, intervention adherence was evaluated by consecutively recruiting eight adult patients per day within 24-48 hours of hospital admission who did not have a current sepsis diagnosis. Patients were recruited from the five study wards where the order of wards was randomly determined each day (Alberto et al., 2020).

## **2.6 Data collection**

Data collection followed the three implementation stages and was prospectively conducted from April to November 2017 (Figure 1).

### **2.6.1 Context Assessment**

The context assessment was undertaken prior introduction of the intervention using the Context Assessment Index (CAI) survey and environmental scanning.

The CAI survey is a validated tool, focused on the “context” element of the PARIHS framework, designed to assess characteristics of a given context in which clinical care is provided and an evidence-based intervention is to be introduced (McCormack, McCarthy, Wright, Slater, & Coffey, 2009). The CAI survey contains 36 items within the areas of Collaborative Practice (9 items), Evidence-informed practice (11 items), Respect for persons (7 items), Practice boundaries (5 items) and Evaluation (4 items). Each item had four response options (strongly agree – strongly disagree). The CAI was forward and back translated independently by two researchers (Maneesriwongul & Dixon, 2004), and was reviewed by key informants to adjust the wording to the setting. One item (Personal and professional boundaries between health care practitioners are maintained) was not well-understood by the informants and therefore was not included.

Environmental scanning was used to identify, assess and understand elements in the environment that might hinder intervention implementation (Charlton et al., 2019). Specific attention was made to electronic and paper-based health records, technology, space, and availability of administrative or aid support. Observations during environmental scanning were documented in field notes. Environmental scanning was conducted on the study wards for 12 days, 4 hours each day, during normal operating hours and after hours.

### **2.6.2 Participation in implementation strategies and intervention adherence**

Data on staff participation in implementation strategies were collected quantitatively (e.g. number of attendees to education sessions, number of rounding encounters). Information on intervention adherence consisted of the number of patients who met the qSOFA-based SS tool criteria, completion of sepsis screening procedures,

alert activations and delivery of any element of the 6-h bundle during the 12-week intervention period (Figure 1).

## **2.7 Data analysis**

All data were entered into either of two password protected secure platforms: REDCap 7.0.11<sup>©</sup> 2018 Vanderbilt University; (Harris et al., 2009) and a Microsoft<sup>®</sup> Excel (version 2016) file.

For the CAI items the median (interquartile range) of responses was determined and the environmental scanning data were summarised descriptively.

Items included in the CAI were dichotomised (agree or disagree), so that where  $\geq 70\%$  of participants agreed or strongly agreed with an item, these were identified as potential facilitators of the intervention. Conversely, where  $< 70\%$  agreed or strongly agreed, these items were considered potential barriers. Further, potential issues with the electronic health records, technology and staff support identified during the environmental scan were considered potential barriers to the intervention implementation. All barriers and facilitators were then thematically clustered into broad categories and used to inform the development of implementation strategies which were deductively linked to the PARIHS framework.

Participation in implementation strategies was summarised and presented in absolute or relative frequencies where applicable. Data to describe intervention adherence were analysed descriptively and presented as absolute or relative frequencies.

## **3 RESULTS**

Findings of this study are presented according to the implementation stages.

### **3.1 Context Assessment**

The overall response rate for the CAI survey was 65% (98 of 150); not all participants provided demographic information (Table 1). Five items had a median score of 3, indicating lower levels of agreement (Supplementary File 2). Of the 36 items in the CAI, 11 were considered to have little relevance to the intervention (Supplementary File 2). For 14 of the remaining 25 items,  $\geq 70\%$  of participants agreed or strongly agreed with the items suggesting these might facilitate intervention implementation; these focused on the importance of education and knowledge, a strong recognition of the role and need for evidence-based practice, and a proactive approach to high quality patient care (Table 2). The remaining 11 items had poor levels of agreement and were considered potential barriers to the implementation; these tended to focus on interpersonal and team structures and processes, including hierarchy, authority and autonomy (Table 2).

Approximately forty-eight hours of environmental scanning in blocks of four to five hours per day were conducted. Potential barriers identified included electronic and paper health records being in high demand, particularly during normal operating hours when access was limited, service interruptions with computing facilities, and limited information technology support. These complemented the findings provided by the CAI survey (Table 2, Categories C and D).

### **3.2 Implementation strategies**

CAI data and results from the environmental scan identified barriers and facilitators, which were thematically clustered into five categories including: educating staff on the evidence-based intervention; collaboration and consultation; facilitation of practice by optimizing available resources; introduction of a systematic approach sepsis

screening and care, and; social influence (Table 2). Implementation strategies to address these areas included a sepsis screening and response guide (SSRG), education sessions, implementation team rounding, posters, champions, audit and feedback and knowledge brokering, in which staff participation was reasonably high (Table 3).

### **3.3 Intervention adherence**

The process of the sepsis screening and the application of the 6-h bundle was evaluated in 547 patients. Of these patients 41/547 (7%) had no documented screening procedures undertaken. Among the patients who had documented screening procedures (n = 506, 92%), only 51 (10%) were screened 100% of the expected times, with the majority of the patients screened  $\geq 60\%$  at set times (Figure 2). Among patients who met the qSOFA-based SS tool criteria (n = 64), only 21 (33%) had a sepsis alert activated. Of the 21 patients for whom a sepsis alert was activated, 16 (76%) received a 6-h bundle element (any cultures or lactate obtained, fluids, vasopressors or antibiotics administered) or a combination of 6-h bundle and other care (Figure 2). Of note, 32 of 43 (74%) patients did not have the sepsis alert activated yet did receive similar treatment as those with alert activated (Figure 2). Some patients who did not receive a 6-h bundle element after meeting the qSOFA-based SS tool criteria (5/21 and 11/43) had received some of the 6-h bundle elements prior to meeting the alert criteria or had do not resuscitate status or were discharged soon after meeting the criteria.

## **4 DISCUSSION**

This multi-method study advances the knowledge about the implementation of sepsis screening, alert activation and care in developing nation health settings by providing a detailed, prospective description of intervention implementation which allows for replication in similar settings. A rigorous assessment of the context provided

a framework to develop and deploy implementation strategies relevant to the setting. Intervention adherence was relatively high, with the majority of recruited patients screened  $\geq 60\%$  of the expected times. Additionally, over 70% of patients meeting the criteria of the qSOFA-based SS tool received elements of the 6h-bundle and other care. However, only one-third of these patients had the sepsis alert activated.

The characteristics of a given context in which a clinical intervention is to be introduced can determine the outcomes of an intervention implementation (Nilsen & Bernhardsson, 2019). These characteristics are also referred to as “determinants” because they are “active intervening variables” which play a pivotal role in intervention uptake (Nilsen & Bernhardsson, 2019). In the present study, determinants derived from a systematic assessment of the context were described as barriers and facilitators (Table 2) and became the framework for developing the implementation strategies (Table 3). This systematic approach to the design of implementation strategies was found effective and well-matched to the setting. The relatively high adherence to the screening procedures and the 6h-bundle may be a result of the deployment of context specific implementation strategies. Similarly, the two thirds of patients who met the criteria of the qSOFA-based SS tool and had no sepsis alert activation may represent the influence of unidentified determinants which require further exploration and development of targeted improvement strategies. Further research will help to better understand what determines successful intervention implementation.

The application of the implementation strategies resulted in a higher and sustained ( $\geq 60\%$ ) adherence to the screening procedures and a higher proportion of patients in need of receiving a 6-h bundle (76%). This was possibly related to the screening tool using a small number of variables routinely assessed and staff

engagement in the adaptation of the tool (Colquhoun, Squires, Kolehmainen, Fraser, & Grimshaw, 2017). Also, the staff in the study setting provided feedback about the screening tool format and its use, as a result, the tool was revised and re-introduced during the first two weeks of initial roll-out consistent with current recommendations for improving engagement and implementation (Colquhoun et al., 2017; Dogherty, Harrison, Baker, & Graham, 2012). This level of engagement is consistent with proactive staff, an enabler identified in the context assessment. People are more likely to change if they make decisions on the processes that affect them (Braithwaite, 2018). Another important factor that could have facilitated the adherence to the intervention is that the bundle elements were usual medical practices, which did not introduce extra work, and nursing and medical leadership were involved in implementation decisions (Dogherty et al., 2012).

In 12-weeks of implementation a small number of patients who met the criteria of the qSOFA-based SS tool had the sepsis alert activated by nurses, and other patients received sepsis care despite the alert not being activated. This finding suggests there is a need to re-examine the process of sepsis alert activation and response. Evidence on clinical deterioration shows nurses experience negative emotions when interacting with rapid response staff (Massey, Chaboyer, & Anderson, 2016), fear of criticism, increased workload, and the perception of traditional contextual hierarchies may cause distress when responding to clinical deterioration (Padilla, Urden, & Stacy, 2018; Walker et al., 2021). These could be possible reasons why a small number of sepsis alerts were activated in the current study. Alternatively, as physicians stayed in the wards most of the normal operation hours and were available for patients, it is likely nurses prioritised oral communication with physicians, which is an effective way of communicating

(Vermeir et al., 2015) rather than formally documenting a sepsis alert activation. With internal medicine and other specialists available, it is possible they could anticipate clinical need early and subsequently provided appropriate care (Edelson et al., 2011). Additionally, 50% of the nursing staff had more than five years of experience (Table 1). More experienced nurses can also recognise clinical cues and make decisions upon those cues (Nibbelink & Brewer, 2018; Thompson, Aitken, Doran, & Dowding, 2013). It is possible that these experienced nurses decided to provide relevant care rather than documenting the alert activation and therefore these data was not available to collect.

The early recognition of sepsis, the activation of sepsis alert, and the provision of treatment is a complex process of care. In a developing nation health setting this can be more challenging because resources may be unavailable (Schultz et al., 2017). Therefore, to implement future improvement initiatives in sepsis care in this type of setting, those responsible for implementation should first understand the setting characteristics and plan accordingly. Ideally, implementation should have a dedicated team and roles must be clearly defined (Dogherty et al., 2012). Staff participation in implementation procedures should be encouraged and may increase adherence and sustainability (Braithwaite, 2018; Dogherty et al., 2012). Implementation strategies that focus on the health care provider should always be paramount. This is particularly important when intervening in workflow processes may not be achievable because electronic records are unavailable or computing facilities are poor, which is common in some health settings in developing nations (Fischer, Lange, Klose, Greiner, & Kraemer, 2016). Staffing levels such as nurse and physician-to-patient ratios, technology such as electronic health records, and cultural sustainability should be carefully considered early in the implementation process.

#### 4.1 Strengthens and limitations

Strengths of the study include the prospective data collection, implementation strategies developed based on an evaluation of the setting, and good intervention adherence. The study being conducted within the setting of time and budget constraints was a limitation. However, it provided evidence of the feasibility of implementing a complex intervention to improve sepsis screening, alert activation and care in a short period of time, and with no additional cost to the study site. The CAI survey was forward and back translated, but it lacks assessment of construct validity in the Spanish language. This could have biased the interpretation of the CAI information. Survey participants were predominantly nurses, with limited participation of physicians. It is likely the assessment of the setting was more representative of nursing perceptions rather than both professional groups. The evaluation of intervention adherence results was limited to the study period, the sustainability of the results was not possible to assess.

An evaluation of the intervention adherence may result in augmenting, readjusting facilitation strategies and tailoring the implementation. This tailoring would have continued if the study period had lasted longer (Blackwood, 2006) and may have included further assessment of barriers, enablers and characteristics of the enacted intervention (Fischer et al., 2016; Pantoja et al., 2017). Implementation is an iterative process in which there is continuous measurement of evidence uptake and revision of implementation strategies. This active process helps the implemented intervention to become a sustainable practice.

## 5 CONCLUSION

This multi-method study reported the description and evaluation of a three-step intervention to improve sepsis screening, alert activation and care in five hospital wards in Argentina. The intervention implementation included the development of implementation strategies informed by a rigorous assessment of practice context. Implementation of the sepsis screening tool using the strategies developed resulted in patients being screened regularly. Patients who met the screening criteria received an element of the 6-h bundle care regardless of having the sepsis alert activated or not suggesting clinical judgement, outside of screening, may be informing treatment decisions. Future research will help to further describe effective implementation strategies that help introduce and sustain sepsis screening, alert activation, and care in developing nation health settings.

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Data collection: Laura Alberto, Fernando Pálizas

Data analysis: Laura Alberto, Andrea P. Marshall, Rachel M. Walker, Fernando Pálizas, Leanne M. Aitken

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**TABLE 1** Context Assessment Index survey participant data

	<b>All</b>	<b>Nurses</b>	<b>Physicians</b>
<b>Age</b>	n = 92	n = 79	n = 13
<b>median (IQR)</b>	36 (14)	37 (14)	31 (10)
<b>Gender, n (%)</b>	n = 94	n = 81	n = 13
<b>male</b>	23 (24)	17 (21)	6 (46)
<b>female</b>	70 (74)	64 (79)	6 (46)
<b>other</b>	1 (1)	0	1 (8)
<b>Years of experience, n (%)</b>	n = 86	n = 75	n = 11
<b>1 to 5</b>	45 (52)	37 (49)	8 (73)
<b>6 to 10</b>	19 (22)	18 (24)	1 (9)
<b>11 to 20</b>	14 (16)	13 (17)	1 (9)
<b>≥21</b>	8 (9)	7 (9)	1 (9)

Notes: 98 participants returned the survey, not all provided demographic information.

**TABLE 2** Categories of barriers and facilitators in which to focus implementation strategies

Categories	Barriers and facilitators	Description of categories
<p><b>A.</b> <b>Educating staff on the evidence-based intervention</b></p>	<p><b>Facilitators:</b> Education is a priority (CAI, EIP); The development of staff knowledge and skills is viewed as a priority by nurse leaders (CAI, EIP); Structured programmes of education are available to all health care practitioners (CAI, EIP); Evidence-based knowledge on care is available to staff (CAI, EIP); All aspects of care/treatment are based on the best evidence (CAI, EIP); Guidelines and protocols based on evidence of best practice (patient experience, clinical experience, and research) are available (CAI, EIP); Health care practitioners have the opportunity to consult with specialists (CAI, EIP); Staff is aware of their own attitudes and beliefs in the provision of care (CAI, PB)</p>	<p>The higher level of agreement in evidence informed practice items was interpreted as staff being receptive to the proposal of an evidence-based intervention in sepsis care</p>
<p><b>B.</b> <b>Collaboration and consultation</b></p>	<p><b>Facilitators:</b> Health care practitioners and health care support workers understand each other's role (CAI, PB); Health care practitioners feel empowered to develop practice (CAI, PB); Health care practitioners share common goals and objectives about patient care (CAI, RP)</p> <p><b>Barriers:</b> Health care practitioners in the multidisciplinary team have equal authority in decision making (CAI, CP); The management structure is democratic and inclusive (CAI, EIP); The organisation is non-hierarchical (CAI, EIP); Nurse leaders create an environment conducive to the development and sharing of ideas (CAI, CP); Organisational management has high regard for staff autonomy (CAI, PB); There are good working relations between patient care and administrative staff, and supporting services (pharmacy, pathology, nutrition and cleaning) (CAI, RP)</p>	<p>The understanding of roles among health care practitioners and their feeling of being empowered to develop their practice was considered would enable staff collaboration and openness to consultations. This strategy would assist to address the perception of an overall hierarchical decision making</p>
<p><b>C.</b> <b>Facilitation of practice by optimizing available resources</b></p>	<p><b>Facilitators:</b> Resources are available to provide evidence-based care (CAI, EIP)</p> <p><b>Barriers:</b> Difficult access to patient information: electronic health record including website of pathology reports, and paper information sources (ES); Frequent interruption / malfunctions of the pager beeper system used to call for medical reviews or emergencies (ES); Limited computing, internet facilities and IT support (ES);</p>	<p>The staff considered they had available resources, this contrasted with the observed limited computing facilities, space and aid support.</p>

	Limited resources for delivering education and displaying material (e.g. colour posters, small ward information boards) (ES); One auditorium for education sessions in high demand (ES); Paper and electronic steps for ordering diagnostic tests orders (ES); Limited access to evidence (ES); Wards had no administrative or aid staff, clinicians were busy with clinical and non-clinical tasks (ES)	Therefore, implementers were to optimize the resources
<b>D. Introduction of a systematic approach sepsis screening and care</b>	<p><b>Facilitators:</b> A proactive approach to care is taken (CAI, CP)</p> <p><b>Barriers:</b> Care is based on a comprehensive assessment (CAI, RP); Nurses had difficulties to assess mental status in patients with previous cognitive impairment (ES); The Glasgow Coma Scale was rarely used (ES); There was no systematic method of identifying patients at risk of developing sepsis (ES); There was no systematic approach, at the organisational level, to the treatment of patients suspected of having sepsis (ES); Staff use reflective processes to evaluate and develop practice (e.g. action learning, clinical supervision, or reflective diaries) (CAI, E); Challenges to practice are supported and encouraged by nurse leaders and nurse managers (CAI, PB); Audit and/or research findings are used to develop practice (CAI, EIP); Sub documentation of patient information (ES); Decisions on care management are clearly documented by all staff (CAI, RP)</p>	Proactive staff would be receptive to the proposed systematic approach to provide sepsis care. This approach was targeting the barriers related to staff perception of patient assessment not being systematic and the lack of feedback on care, and decisions on care poorly documented
<b>E. Social influence</b>	<b>Facilitators:</b> The leader regardless of his/her discipline acts as a model of good practices (CAI, RP)	Senior clinicians were respected and considered role models. Therefore, their opinion would be valued by staff

Note: Collaborative practice (CP), Evidence-informed practice (EIP), Respect for persons (RP), Practice boundaries (PB) and Evaluation (E) are domains within the Context Assessment Index survey.

Abbreviations: GCS, Glasgow Coma Scale; ES, Environmental Scanning; IT, Information Technology.

**TABLE 3** Implementation strategies developed, staff participation, link to categories of barriers and facilitators, and link to PARIHS framework

Strategy	Description of strategy	Medium to deliver the strategy	Staff participation	Link to categories	Link to PARIHS framework
Sepsis Screening and Response Guide (SSRG)	Content consisted of an explanation of variables to screen (qSOFA score and suspicion of infection), the 6-h bundle (obtaining cultures, administering antibiotics, measuring lactate, administering fluids and vasopressors) and a rationale to share screen for sepsis	Formal education sessions Email Printed copies available in the wards	~90% staff	A	Evidence Facilitation
Education session	Presentation of the SSRG, with details on the treatment	--	92% nurses, ~90% physicians	A	Facilitation
Education session	World Sepsis Day was focused on sepsis as a global problem, supporting evidence on recognition and treatment	--	~64 (nurses and physicians)	A, B	Facilitation
Implementation team rounding	Rounds to support bedside staff during 12-week implementation period	--	24 encounters (individual or nursing teams)	C, D, E	Facilitation
Sepsis screening and care A4 poster	Summary, visual reminder of how to screen and respond to sepsis	Displayed in ward boards, distributed via WhatsApp	--	A, C, D	Evidence Context Facilitation
Glasgow Coma Scale A4 poster	Visual reminder and assessment procedure	Displayed in ward boards, distributed via WhatsApp	--		Evidence Context Facilitation

Champions	Bedside nurses, one per nursing shift, acted as source of information and support for their peers	--	--	B, C, D	Context Facilitation
Audit and feedback	Screening procedures related to what was expected to happen was shared to all wards. Description of treatment provided to alerted patients was also included.	Audit results were provided through print and electronic media	Feedback reports provided	D, E	Facilitation Successful Implementation
Knowledge brokering, conversations on sepsis†	To bridge the evidence and clinical practice gap by facilitating access to, and discussion of, the latest evidence on sepsis care (Ward, House, & Hamer, 2009). Sepsis research published in English was summarised and presented in Spanish during a short work break.	Brief (10-15 min) face-to-face meetings	9 nurses (predominantly night shifts)	A, C, E	Facilitation
Knowledge brokering, delivery of sepsis papers	Sourcing and sharing articles on sepsis with staff (on request)	Email	6 physicians 1 nurse	A, C, E	Facilitation

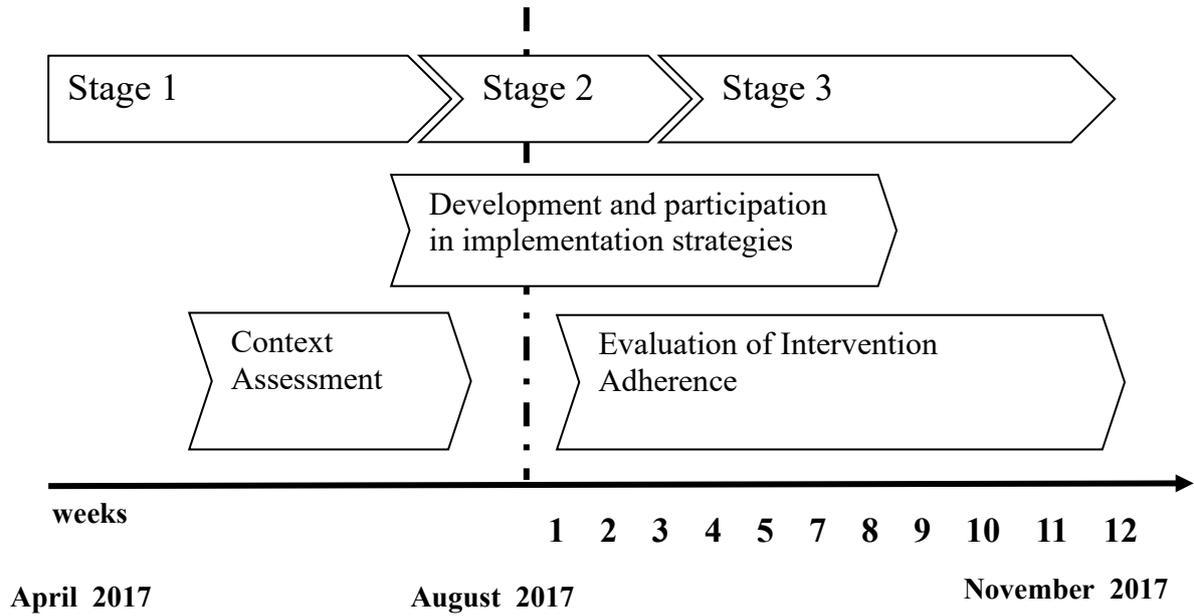
Abbreviation: PARiHS, Promoting Action on Research Implementation in Health Services; qSOFA, quick Sequential [Sepsis-Related] Organ Failure Assessment.

Notes:

~Approximate.

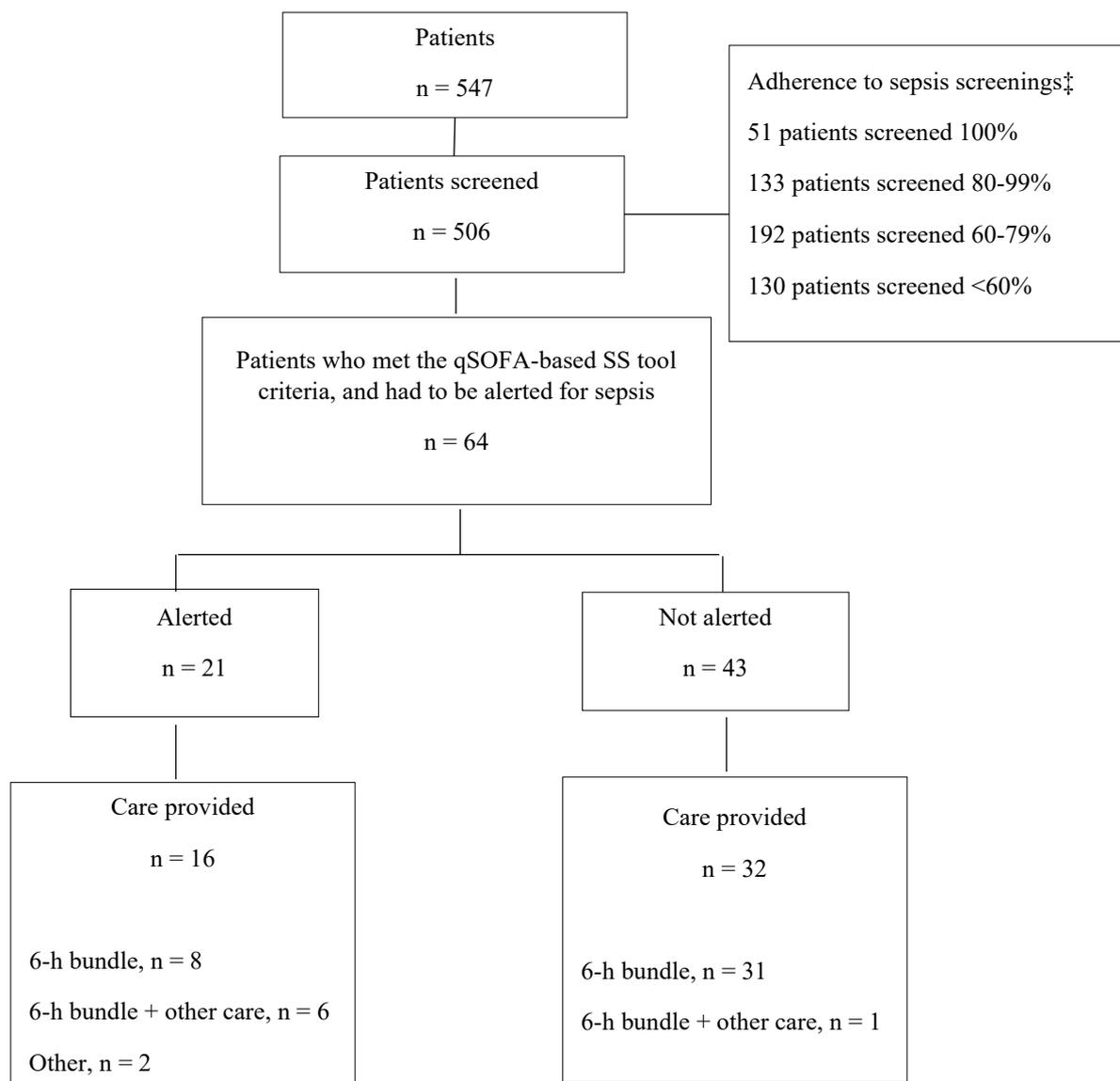
†This strategy was planned for helping clinicians who did not read English to access evidence in English language.

## Introduction of intervention: qSOFA-based sepsis screening tool and 6-h bundle



Abreviation: qSOFA, quick Sequential [Sepsis-Related] Organ Failure Assessment

**FIGURE 1** Study Timeline



Abbreviations: qSOFA, quick Sequential [Sepsis-Related] Organ Failure Assessment; SS, sepsis screening.

Notes:

Other care was  $\geq 1$  of the following: Medication orders (Steroids, electrolytes, glucose bolus, antipyretics, immunoglobulin, antacids, antiemetics, antihistamine, furosemide infusion), respiratory support (oxygen, non-invasive ventilation, nebulization), diagnostic test orders (Computed tomography scan, cardiac enzymes pathology and echo-cardiogram) and do not resuscitate decision.

Only the first 6-h bundle element implemented was considered, any culture or lactate obtained, fluids, vasopressors or antibiotics administered.

‡100% mean the patient was screened for sepsis in all nursing observations during whole admission in the study wards.

**FIGURE 2** Adherence to sepsis screening and application of 6-h bundle

## Improving sepsis screening and care in a developing nation health setting: a description of implementation

### Supplementary FILE 1 - Supplementary TABLE Revised Standards for Quality Improvement Reporting Excellence (SQUIRE 2.0)

Text Section and Item Name	Section or Item Description	Pages
Title and Abstract		
1. Title	Indicate that the manuscript concerns an initiative to improve healthcare (broadly defined to include the quality, safety, effectiveness, patient-centeredness, timeliness, cost, efficiency, and equity of healthcare)	1
2. Abstract	a. Provide adequate information to aid in searching and indexing b. Summarize all key information from various sections of the text using the abstract format of the intended publication or a structured summary such as: background, local problem, methods, interventions, results, conclusions	1
Introduction		
<i>Why did you start?</i>		
3. Problem Description	Nature and significance of the local problem	5
4. Available knowledge	Summary of what is currently known about the problem, including relevant previous studies	3-5
5. Rationale	Informal or formal frameworks, models, concepts, and/or theories used to explain the problem, any reasons or assumptions that were used to develop the intervention(s), and reasons why the intervention(s) was expected to work	5
6. Specific aims	Purpose of the project and of this report	6
Methods		
What did you do?		
7. Context	Contextual elements considered important at the outset of introducing the intervention(s)	8
8. Intervention(s)	a. Description of the intervention(s) in sufficient detail that others could reproduce it b. Specifics of the team involved in the work	7-8
9. Study of the Intervention(s)	a. Approach chosen for assessing the impact of the intervention(s) b. Approach used to establish whether the observed outcomes were due to the intervention(s)	10 NA
10. Measures	a. Measures chosen for studying processes and outcomes of the intervention(s), including rationale for choosing them, their operational definitions, and their validity and reliability b. Description of the approach to the ongoing assessment of contextual elements that contributed to the success, failure, efficiency, and cost c. Methods employed for assessing completeness and accuracy of data	NA NA
11. Analysis	a. Qualitative and quantitative methods used to draw inferences from the data b. Methods for understanding variation within the data, including the effects of time as a variable	10-11 NA
12. Ethical Considerations	Ethical aspects of implementing and studying the intervention(s) and how they were addressed, including, but not limited to, formal ethics review and potential conflict(s) of interest	6
Results		
What did you find?		

13. Results	a. Initial steps of the intervention(s) and their evolution over time (e.g., time-line diagram, flow chart, or table), including modifications made to the intervention during the project b. Details of the process measures and outcome c. Contextual elements that interacted with the intervention(s) d. Observed associations between outcomes, interventions, and relevant contextual elements e. Unintended consequences such as unexpected benefits, problems, failures, or costs associated with the intervention(s). f. Details about missing data	12  13 12 NA  13 NA
Discussion	What does it mean?	
14. Summary	a. Key findings, including relevance to the rationale and specific aims b. Particular strengths of the project	13-14  17
15. Interpretation	a. Nature of the association between the intervention(s) and the outcomes b. Comparison of results with findings from other publications c. Impact of the project on people and systems d. Reasons for any differences between observed and anticipated outcomes, including the influence of context e. Costs and strategic trade-offs, including opportunity costs	NA  NA NA 14-15  NA
16. Limitations	a. Limits to the generalizability of the work b. Factors that might have limited internal validity such as confounding, bias, or imprecision in the design, methods, measurement, or analysis c. Efforts made to minimize and adjust for limitations	17 NA  NA
17. Conclusions	a. Usefulness of the work b. Sustainability c. Potential for spread to other contexts d. Implications for practice and for further study in the field e. Suggested next steps	17-18 17 16 16 16-17
Other information		
18. Funding	Sources of funding that supported this work. Role, if any, of the funding organization in the design, implementation, interpretation, and reporting	Provided in the title page

NA, not applicable

## Improving sepsis screening and care in a developing nation health setting: a description of implementation

### Supplementary FILE 2 - Supplementary TABLE Context Assessment Index survey results

	n	Median (IQR)	Agreement %
<b>1 – Collaborative practice</b>			
1. A proactive approach to care is taken	95	2 (0)	82**
2. Health care practitioners provide opportunities for patients to participate in decisions about their own care	94	2 (1)	73 <sup>£</sup>
3. Health care practitioners in the multidisciplinary team have equal authority in decision making	94	3 (1)	24*
4. Patients are encouraged to be active participants in their own care	91	2 (1)	80 <sup>£</sup>
5. Health care practitioners and patients work as partners, providing individual patient care	89	2 (1)	71 <sup>£</sup>
6. Discussions are planned between health care practitioners and patients	90	3 (1)	48 <sup>£</sup>
7. Patients have choice in assessing, planning, and evaluating their care and treatment	88	2 (1)	58 <sup>£</sup>
8. Nurse leaders create an environment conducive to the development and sharing of ideas	89	2 (2)	64*
9. Patients are encouraged to participate in feedback on care	89	2 (1)	66 <sup>£</sup>
<b>2 – Evidence-informed practice</b>			
10. All aspects of care/treatment are based on the best evidence	94	2 (0)	76**
11. Education is a priority	94	1 (1)	90**
12. Audit and/or research findings are used to develop practice	89	2 (1)	53*
13. The management structure is democratic and inclusive	89	3 (1)	38*
14. The development of staff knowledge and skills is viewed as a priority by nurse leaders	91	2 (2)	74**
15. Evidence-based knowledge on care is available to staff	89	2 (0)	83**
16. Health care practitioners have the opportunity to consult with specialists	89	2 (0)	79**
17. Guidelines and protocols based on evidence of best practice (patient experience, clinical experience, and research) are available	89	2 (1)	83**
18. Resources are available to provide evidence-based care	86	2 (0)	76**
19. The organisation is non-hierarchical	86	3 (1)	34*
20. Structured programmes of education are available to all health care practitioners	90	2 (2)	71**

<b>3 – Respect for persons</b>			
21. Decisions on care management are clearly documented by all staff	95	2 (3)	67*
22. The leader regardless of his/her discipline acts as a model of good practices	93	2 (1)	72**
23. There are good working relations between patient care and administrative staff, and supporting services (pharmacy, pathology, nutrition and cleaning)	94	2 (1)	69*
24. There is high regard for patient's privacy and dignity	91	2 (1)	85 <sup>£</sup>
25. Care is based on a comprehensive assessment	89	2 (1)	66*
26. Staff welcome and accept cultural diversity	91	2 (1)	91 <sup>£</sup>
27. Health care practitioners share common goals and objectives about patient care	91	2 (1)	79**
<b>4 – Practice boundaries</b>			
28. Staff is aware of their own attitudes and beliefs in the provision of care.	88	2 (0)	80**
29. Health care practitioners and health care support workers understand each other's role	89	2 (2)	72**
30. Challenges to practice are supported and encouraged by nurse leaders and nurse managers	88	2 (1)	63*
31. Organisational management has high regard for staff autonomy	89	2 (1)	62*
32. Health care practitioners feel empowered to develop practice	89	2 (0)	82**
<b>5- Evaluation</b>			
33. Staff receive feedback on the outcomes of complaints	94	2 (1)	51 <sup>£</sup>
34. A staff performance review process is in place that enables reflection on practice and goal setting and is regularly reviewed	89	3 (1)	48 <sup>£</sup>
35. Appropriate information (large written print, tapes, etc.) is accessible to patients	89	2 (1)	51 <sup>£</sup>
36. Staff use reflective processes (e.g., action learning, clinical supervision, or reflective diaries) to evaluate and develop practice	90	2 (1)	57*

Abbreviation: IQR, Interquartile Range

Notes: Survey points presented as median (IQR): 1, strongly agree; 2, agree; 3, disagree; 4, strongly disagree.

The CAI items strongly agree and agree were included in the agreement group, and options disagree and strongly disagree in the disagreement group; items  $\geq 70\%$  of agreement were considered facilitators\*\*, and items  $< 70\%$  of agreement were considered barriers\*.

<sup>£</sup>Items not included as barriers; strategies to address those barriers were out of the scope of the study.