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# Sepsis now a priority: a quality improvement initiative for early sepsis recognition and care

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## Abstract

**Objective:** To develop a triage-based screening algorithm and treatment order-sets aimed at improving the quality of care of all patients with sepsis presenting to our emergency department (ED).
**Design:** Retrospective cohort study conducted during a pre-intervention period from 1 April 2010 to 31 March 2011 and a post-intervention period from 1 September 2014 to 30 April 2015.
**Setting:** A large teaching hospital located in Toronto, Ontario, Canada with a 35-bed ED.
**Participants:** All patients meeting pre-specified sepsis criteria during the ED encounter.
**Main Outcome Measures:** Process of care measures included time to assessment by emergency physician, lactate measurement, blood culture collection, fluid and antibiotic administration. Intensive care unit (ICU) outcomes including admissions, length of stay (LOS) and deaths were reviewed.
**Results:** There were 346 patients pre-intervention, and 270 patients post-intervention. We significantly improved all process measures including mean time to antibiotics by 60 min ($P = 0.003$) and proportion of patients receiving fluid resuscitation (64.7% vs. 94.4%, $P < 0.001$). There was no significant difference in the number of patients admitted to ICU ($P = 0.14$). The median ICU LOS was shorter in the post-intervention group [2.0 days (interquartile range (IQR) 1.0–4.5 days) vs. 5.0 days (IQR 1.5–10.8 days), $P = 0.04$], and there was no difference in in-hospital mortality between groups ($P = 0.27$).
**Conclusions:** We have demonstrated that a triage-based sepsis screening tool results in expedited and consistent delivery of care, with a significant improvement in initial resuscitation measures.

**Key words:** quality improvement, sepsis care, sepsis protocol, bundles, electronic alerts

## Introduction

### Background

Globally, sepsis is a leading cause of morbidity and mortality with an associated economic burden that extends beyond hospital length of stay (LOS) [1]. In Canada (excluding Quebec), sepsis accounts for 30 857 hospital admissions, and is responsible for 10.9% of all in-hospital deaths [2]. One of the greatest challenges in sepsis care is recognition of the syndrome, which is often complicated by comorbid conditions, advanced patient age and disease severity [3].

The adoption of emergency department (ED)-based protocols focusing on early detection and treatment of patients with sepsis arose from the Early Goal Directed Therapy (EGDT) protocol published by Rivers *et al.* in 2001 [4]: by implementing resuscitation targets and time-sensitive therapies in the ED, mortality was reduced by 16% in patients with severe sepsis. Since 2002, the Surviving Sepsis Campaign (SSC) has focused on developing a consensus definition of sepsis, population education and evidence-based guidelines stressing a 'bundle' approach to sepsis management, reinforcing the importance of early care [3, 5, 6]. Despite these guidelines, the approach to sepsis has remained heterogeneous across specialties and countries [7]. There is no consensus on sepsis bundle components or time targets, and a paucity of quality metrics to evaluate effectiveness [8].

Three recently published multicenter randomized control trials failed to show a mortality benefit in patients with septic shock receiving protocol-based EGDT versus usual care [9–11]. The optimal management of patients presenting with uncomplicated sepsis remains unclear, but one-fifth of these patients will progress to severe sepsis or septic shock within 48 h of presentation [12].

### Local problem

Mount Sinai Hospital is a large teaching hospital located in Toronto, Ontario, with a 35-bed ED. We sought to identify both the burden of sepsis and deficiencies in care of patients with sepsis presenting to our ED. We reviewed sepsis cases managed in the ED during the 2010–11 fiscal year and identified delays in sepsis recognition and time-sensitive interventions, including fluid and antibiotic administration, and variability in care between providers.

### Intended improvement

We formed a working group of key stakeholders with the aim of developing a triage-based algorithm to screen for sepsis and rapidly deliver standardized care in our ED: sepsis now a priority (SNAP).

There have been few studies describing triage-based screening tools for patients with suspected sepsis [13–19], with most of these studies focussing on the optimal care of patients with severe sepsis and septic shock [16–19]. The aim of our quality initiative was to improve the identification, process of care and ultimately outcomes of all patients presenting to our ED with sepsis.

The objective of this paper is to describe the process of our protocol development and implementation, and the measurement of its impact in our patient cohort.

## Methods

We obtained institutional ethics board approval for the review of patient records. There are no conflicts of interest to report.

### Setting

This study was conducted at Mount Sinai Hospital (MSH), a 472-bed teaching hospital in downtown Toronto. The 35-bed ED had 48 709 visits during the 2010/11 fiscal year and 61 190 visits during the 2014/15 fiscal year. The pre-intervention period was between 1 April 2010 and 31 March 2011 and post-intervention period was between 1 September 2014 and 30 April 2015.

The SNAP working group had an executive sponsor, and included stakeholders from the emergency, infectious diseases, intensive care, internal medicine and pharmacy departments. The group first met in December 2013 to develop the project charter, and monthly thereafter. Our aim was to produce an algorithm to identify patients with sepsis at the point of triage, to standardize our approach to diagnosis and management based on current evidence-based practice, and to improve upon deficiencies identified from the pre-intervention chart review. Pre-intervention process mapping was completed (Fig. 1), with opportunities for change identified. Protocol development, institutional approval and staff education were completed over 7 months (Appendix 1).

### Baseline cohort

Pre-intervention patient records were identified using an overly inclusive coding methodology followed by chart review. ICD-10-CA codes [20] for sepsis, septicemia and all infections were included (Appendix 2). An electronic inclusion form was designed after the 2001 International Sepsis Definitions Conference criteria [21] to identify patients with sepsis. Sepsis was defined as the presence of the systemic inflammatory response syndrome (SIRS) in addition to a suspected or confirmed source of infection. Patient records were excluded if there was a concurrent acute non-infectious illness accounting for a SIRS phenomenon, or a palliative status with no active medical therapy at presentation. Data was abstracted between November 2011 and March 2012.

### Post-intervention cohort

Patients presenting to triage with either a suspected infection or a known risk factor for sepsis (hospitalization within the prior 6 weeks, current chemotherapy, presence of an indwelling catheter or central line), in addition to two or more of the SIRS criteria [21] or unexplained hypotension (mean arterial pressure <65 mmHg) received an electronic sepsis flag. Patients were included in the post-intervention cohort if they received an electronic sepsis flag and were admitted to hospital. Patients with a non-sepsis diagnosis, defined by electronic termination of the SNAP algorithm, were excluded from the data analysis. Data was collected in real-time through the electronic patient record and reviewed by a nurse practitioner.

### Intervention

Our initiative included an algorithm outlining patient inclusion criteria, interventions and time targets for clinicians to meet (Fig. 2), pre-printed paper order-sets for sepsis recognition and ongoing care, an electronic sepsis indicator for the patient tracking board with linked data collection, electronic order-sets specific to sepsis care and nursing medical directives aligned with the SNAP algorithm.

Education of frontline staff began 4 months prior to the implementation of the algorithm, and was delivered during nursing education days, frontline staff meetings, departmental grand rounds and electronic communication. The ED staff was familiar with protocol-driven

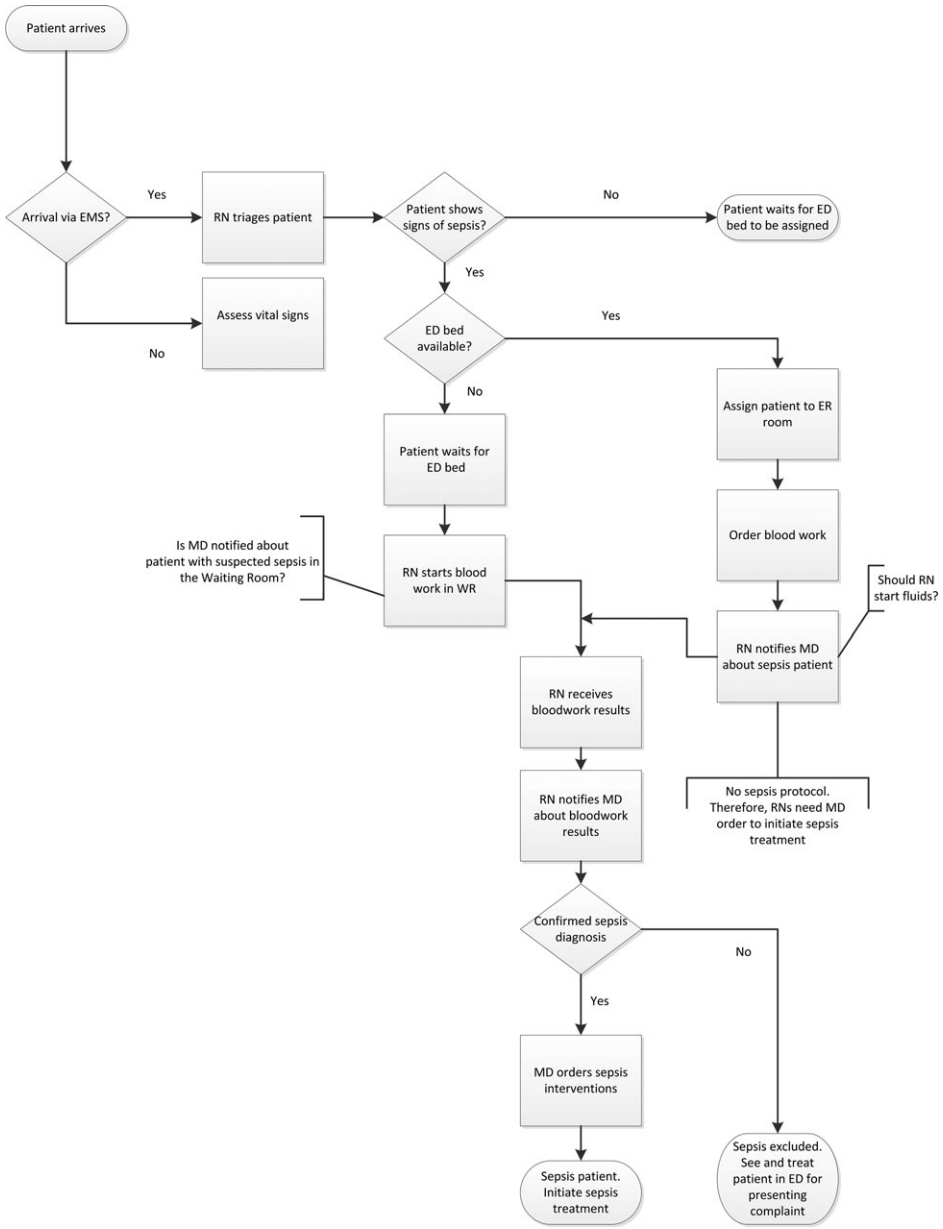


**Figure 1** Pre-intervention process map of patient journey with suspected sepsis through the emergency department, with identified areas for improvement. Emergency medical services (EMS), registered nurse (RN), medical doctor (MD), Emergency Department (ED), waiting room (WR).

care, with pre-existing algorithms in place for the management of hip fracture, acute coronary syndrome and stroke. The SNAP initiative was socialized within the institution via informational posters in high traffic areas, screensavers and lanyards.

The SNAP algorithm was initiated by the triage nurse; patients meeting inclusion criteria (Fig. 2) were triaged as Canadian Triage and Acuity Scale (CTAS) 1 or 2 [22]. An electronic sepsis flag was initiated at triage to alert the healthcare team, and appeared on the patient tracking board. The SNAP algorithm and order set were initiated: Initial resuscitation orders including clinical monitoring parameters, oxygen application, urinary catheter insertion, peripheral IV insertion and a 1-L bolus of normal saline were approved by the hospital as nursing medical directives and designed to be executed independently by the nursing team prior to physician assessment. Electronic order-sets containing pre-selected standard blood work including lactate and blood cultures were used.

Further guides for ongoing fluid resuscitation and antimicrobial therapy were included in the paper order set based on current best practices and approved by our institution's Antimicrobial Stewardship Program. If alternate diagnoses were suspected, the SNAP algorithm was terminated by the care provider, with removal of the electronic flag.

SNAP algorithm performance data was tracked and relayed to frontline staff monthly using a sepsis scorecard prepared by a nurse practitioner. The scorecard included key targets for process improvement, including time to physician and nurse assessment, time to blood culture and lactate draw, and time to fluid and antimicrobial administration. Process measures were stratified according to the time targets outlined in the SNAP algorithm, and color-coded green if time targets were met, yellow if the process measure was within 5 min of the target time, and red if the time target was not met. Scorecard information was used to both highlight the achievement of our targets, and to identify areas for improvement.

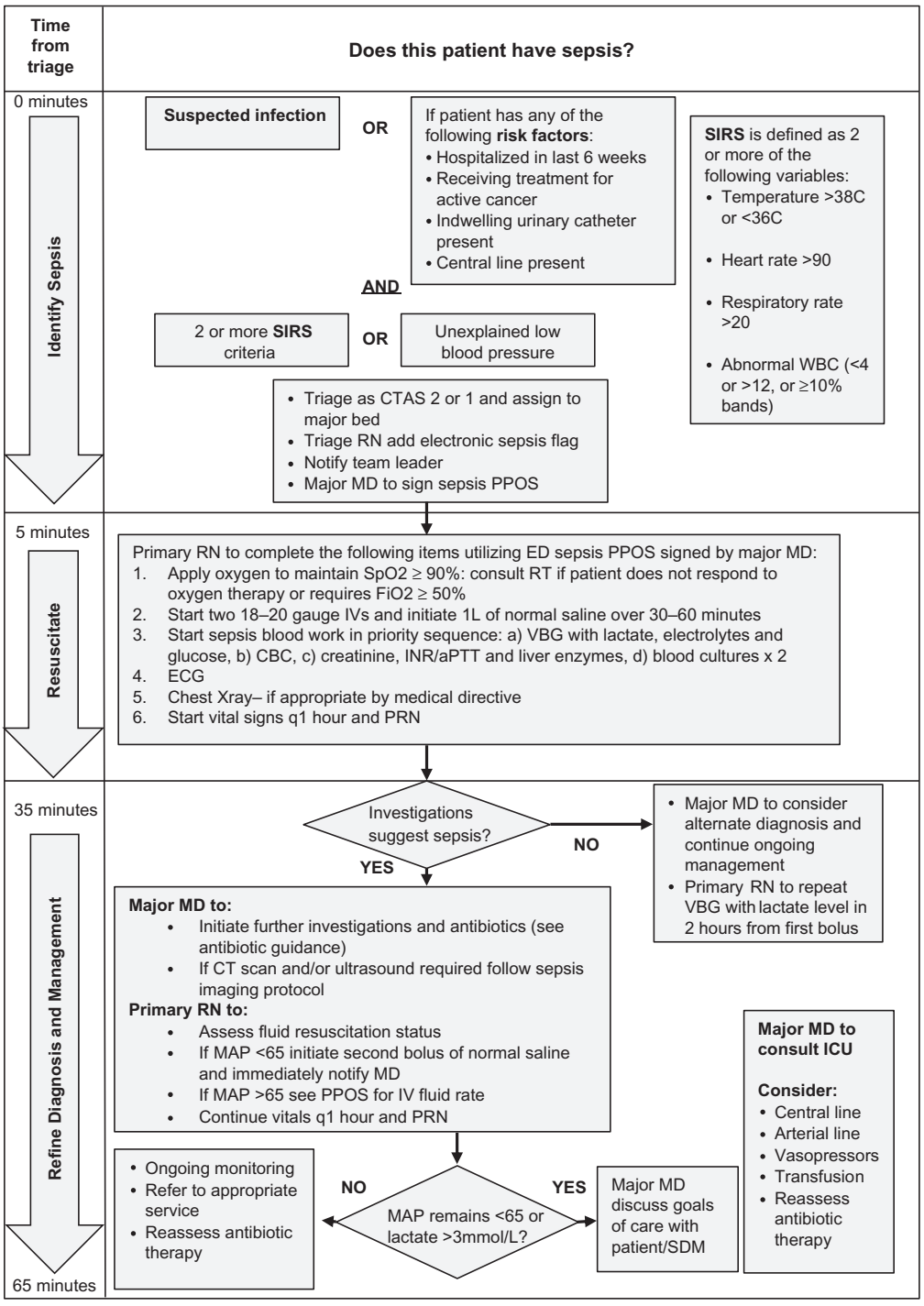


**Figure 2** Sepsis algorithm developed by stakeholders following completion of process mapping, review of baseline data and identification of local problems in sepsis care. The algorithm focuses on (1) identifying sepsis, (2) resuscitation, (3) refinement of diagnosis and ongoing management. Time targets are specified for each component of the algorithm. Registered nurse (RN), pre-printed order set (PPOS), medical doctor (MD), Emergency Department (ED), white blood cell count (WBC), Systemic Inflammatory Response Syndrome (SIRS), Respiratory Therapist (RT), venous blood gas (VBG), mean arterial pressure (MAP), Canadian Triage and Acuity Scale (CTAS), Celcius (C).

## Outcomes

Process of care measures included time to assessment by emergency physician, lactate measurement, blood culture collection, fluid and antibiotic administration. Separate analyses of patients admitted to intensive care unit (ICU), including the process of care measures, ICU LOS and mortality were performed.

## Evaluation

Pre-intervention, patient demographics, process of care measures and ICU outcomes were studied. Process of care measures was analyzed within the first 24 h from arrival at triage. A physician reviewed patient records. All accessible records (emergency room data sheets, consultant and progress notes, electronic records and

death certificates) were examined. The first 50 patient records were reviewed at the outset of data abstraction, and once again at the end of the study to ensure reproducibility of the inclusion criteria. ICU admissions between 1 August 2010 and 30 March 2011 were included in the ICU-only analysis.

The intervention began on 21 July 2014, and post-intervention data were collected after a 6-week run-in period. All ICU admissions underwent chart review to confirm that sepsis was present. Patients were excluded from the ICU data analysis if sepsis was not the reason for ICU admission, or if the ICU admission occurred more than 24 h from the time of triage. A physician and nurse practitioner reviewed charts.

Statistical analysis was performed using the student t-test for comparison of continuous variables, and the Chi-Square test for comparison of dichotomous outcomes, as appropriate. The description of continuous variables and means are provided with 95% confidence intervals. The Mann–Whitney *U*-test was used for comparison of medians. Medians are reported with the interquartile range (IQR).

**Table 1** Descriptive data

| Variable | Pre-intervention | Post-intervention | *P*-value |
|---|---|---|---|
| Number of patient records meeting inclusion criteria | 346 | 270 | |
| Age (years, mean with 95% CI) | 68.6 (66.4–70.7) | 66.1 (63.6–68.6) | 0.14 |
| Gender (Male), *n* (%) | 168 (48.6) | 127 (47.0) | 0.71 |
| Admission location: *n* (%)[a] | | | |
| ICU | 40 (11.6) | 17 (6.3) | 0.03 |
| Ward or special care unit[b] | 306 (88.4) | 253 (93.7) | |
| Infection source: n (%) | | | |
| Pneumonia | 167 (48.3) | 87 (32.2) | <0.001 |
| Urinary tract | 119 (34.3) | 59 (21.9) | <0.001 |
| Intraabdominal | 34 (9.8) | 35 (13.0) | 0.22 |
| Skin and soft tissue | 9 (2.6) | 17 (6.3) | 0.02 |
| Other[c] | 17 (4.9) | 45 (16.7) | <0.001 |
| No evidence of infection | n/a | 27 (10.0) | |
| Proportion with positive blood culture, *n* (%) | 81 (24.6) | 50 (18.7) | 0.14 |

CI, confidence intervals; ICU, intensive care unit.

[a]Patient admission location within 24 h of triage time.

[b]Medical or surgical special care unit.

[c]Other: meningitis, bone and joint infection, endocarditis, central catheter related infection, bacteremia, febrile illness not yet diagnosed.

## Results

There were 346 patient records identified pre-intervention, and 270 patient records post-intervention. The majority of sepsis cases were admitted to medical and surgical wards both pre- and post-intervention. There were significantly more cases of pneumonia and urinary tract infections in the pre-intervention cohort (Table 1).

Review of baseline performance revealed numerous areas for improvement, including time to antibiotic administration of >3 h, delays in fluid resuscitation and under-resuscitation with less than the recommended 30 ml/kg of crystalloid administered [3]. Fluid was administered in only 65% of sepsis cases, and lactate was measured in only 76% of cases (Table 2).

All process measures were improved post-intervention and reached statistical significance (Table 2). The proportion of patients receiving early fluid resuscitation was significantly greater after the SNAP algorithm implementation (64.7% vs. 94.4%, $P < 0.001$). The mean time to antibiotics was reduced by 1 h after the implementation of the SNAP algorithm. Resuscitation was achieved in <3 h from the time of triage in the post-SNAP algorithm group, in keeping with SSC recommendations [3].

In the ICU analysis, the median ICU LOS was significantly shorter post-intervention [2.0 days (IQR 1.0–4.5 days) vs. 5.0 days (IQR 1.5–10.8 days), $P = 0.04$]. There was no significant difference in in-hospital mortality in patients who were admitted to the ICU (40% vs. 24%, $P = 0.27$) (Table 3). Mean time to antibiotic administration was shorter by 100 min in the post-intervention group ($P = 0.01$). There was no difference in the proportion of patients receiving antibiotics between groups ($P = 0.34$) (Table 4). The number of patients with positive blood cultures was similar between groups.

## Discussion

We designed, implemented and assessed the impact of a unique triage-based algorithm for early sepsis screening and care in our ED over the course of 18 months. We significantly reduced the time to antibiotic administration and fluid resuscitation, improved compliance with fluid administration, blood culture and lactate measurement and minimized variability in our care of patients with sepsis. For patients admitted to the ICU, we demonstrated a reduction in time to antibiotic administration, as well as a shorter ICU LOS. We employed real-time quality metrics to evaluate algorithm compliance and effectiveness.

**Table 2** Study process measures within 24 h of triage pre- and post-SNAP algorithm implementation, mean with 95% CI

| Process measure | Pre-intervention *n* = 346 | Post-intervention *n* = 270 | *P*-value |
|---|---|---|---|
| Time to assessment by emergency physician (min) | 99.8 (92.2–107.4) | 77.4 (72.0–82.7) | <0.001 |
| Proportion with lactate measured, *n* (%) | 264 (76.3) | 267 (98.9) | <0.001 |
| Time to lactate draw (min) | 131.1 (111.3–150.9) | 71.8 (65.4–78.2) | <0.001 |
| Proportion with blood cultures taken, *n* (%) | 329 (95.1) | 268 (99.3) | 0.003 |
| Time to blood culture draw (min) | 109.8 (94.4–125.2) | 73.5 (66.8–80.2) | <0.001 |
| Time to antibiotic administration (min) | 253.9 (233.5–274.3) | 191.8 (155.5–228.0) | 0.003 |
| Proportion receiving fluid bolus, *n* (%) | 224 (64.7) | 255 (94.4) | <0.001 |
| Time to first fluid bolus (min) | 131.0 (119.3–142.7) | 90.7 (80.4–101.0) | <0.001 |

CI, confidence intervals; SNAP, sepsis now a priority.

The SNAP quality initiative has changed the way we deliver care to patients with sepsis at our institution. Our study adds to a small body of literature describing triage-based sepsis screening [13–19]. We believe that screening for sepsis at the earliest point of patient-hospital contact allowed us to broaden recognition and improve subsequent care. Recently published RCTs [9–11] failed to find a mortality difference between protocol-driven sepsis care and 'usual care'; these studies included patients with septic shock who received expedited fluids [9–11] and antibiotics [9, 11] within 2 h of hospital presentation. Our sepsis algorithm captured a different group of sepsis patients; the majority did not meet criteria for septic shock or require ICU admission, and we focused on early identification and care. A recently published study has similarly demonstrated that early sepsis screening interventions led to expedited delivery of care in the ED, without a reduction in mortality [14]. There were parallels between this study and ours, most importantly a population that included uncomplicated sepsis, the use of an electronic sepsis alert and the focus on a nurse-driven screening tool [14]. These elements should now be considered standard for ED-based sepsis process improvement where resources allow.

We attributed rapid assimilation of the SNAP algorithm at our institution to institutional buy-in, an effective educational campaign, and the familiarity of the frontline staff with protocols, electronic alerts and order-sets which are frequently used in the ED. Initially, there was over-inclusion of patients, with a high number of discharges and algorithm terminations (Appendix 3). The pattern of algorithm usage stabilized over time. Monthly feedback delivered using the sepsis scorecard reinforced protocol compliance and facilitated ongoing education related to the appropriate application of the algorithm. Ongoing support and process review from a nurse practitioner was a key component in maintaining regular use of the algorithm, identifying and troubleshooting problems as they arose. Our use of integrated quality metrics is unique [8]. Other studies have demonstrated similar reductions in the variability of care after implementing protocols and order-sets [14, 23–27]. As a balancing measure, we found that there was no significant difference in sepsis admissions to ICU before and after the SNAP protocol was implemented; to our knowledge, the protocol did not result in increased ICU resource utilization.

The SNAP initiative was unique in its interdisciplinary approach, with a focus on shared care between nursing staff and emergency physicians. Nursing staff were represented in the SNAP working group, and played a key role in protocol development and assessment, including collection of the monthly scorecard metrics. Emergency nurses are the first point of patient contact at triage and within the ED, and we felt it was essential for the nursing staff to have autonomy in identifying sepsis and beginning resuscitative efforts. We gained institutional approval for nursing medical directives to facilitate this. We reduced the delays in blood work collection and fluid administration that previously required a physician's order. Other studies have also demonstrated improvement in process measures with protocols focusing on nursing staff engagement [13, 23, 26, 28, 29].

**Table 3** Outcomes of patients admitted to ICU from the emergency department within 24 h, over an 8-month period

| Outcome measure | Pre-intervention[a] | Post-intervention | *P*-value |
|---|---|---|---|
| ICU admission within 24 h, *n* (%) | 25 (9.8) | 17 (6.3) | 0.14 |
| Proportion with positive blood culture, *n* (%) | 8 (32.0) | 8 (47.1) | 0.32 |
| ICU length of stay in days, median with IQR | 5 (1.5–10.8) | 2 (1.0–4.5) | 0.04 |
| Deaths in ICU, *n* (%) | 7 (28.0) | 4 (23.5) | 0.75 |
| Deaths during same hospital admission, *n* (%) | 10 (40.0) | 4 (23.5) | 0.27 |

ICU, intensive care unit; IQR, interquartile range.

[a]Pre-intervention data over the time period of 1 August 2010–30 March 2011, $n = 256$.

## Limitations

The reduction in ICU LOS was unexpected. There was no significant difference in the number of patients admitted to ICU pre- and post-intervention. Sepsis was present in all patients admitted to the ICU, and there was no significant difference in blood culture positivity between groups. The proportion of positive blood cultures in the ICU group was similar to that of the ProCESS and ARISE trials [10, 11]. A recent study has described an association between early antibiotic administration and reduction in hospital LOS, although the effect was small [30]. The pre-intervention group had several long-stay ICU patients, which likely contributed to the difference. Confounders such as hospital bed-flow patterns and physician practices relating to goals of care discussions may have changed over the duration of our study, and therefore we cannot conclude that the reduced LOS is directly related to the implementation of our

**Table 4** Study process measures pre- and post-SNAP algorithm implementation for patients admitted to ICU within 24 h of triage, mean with 95% CI

| Process measure | Pre-intervention $n = 25$ | Post-intervention $n = 17$ | *P*-value |
|---|---|---|---|
| Age (years, mean with 95% CI) | 65.3 (56.7–73.9) | 66.8 (57.9–75.7) | 0.80 |
| Gender (Male), *n* (%) | 14 (56.0) | 12 (70.6) | 0.33 |
| Time to assessment by emergency physician (min) | 91.7 (58.2–125.1) | 55.8 (35.1–76.5) | 0.07 |
| Proportion with lactate measured, *n* (%) | 25 (100.0) | 17 (100.0) | 1.0 |
| Time to lactate draw (min) | 154.0 (79.8–228.3) | 73.1 (49.1–97.1) | 0.04 |
| Proportion with blood cultures taken, *n* (%) | 25 (100) | 17 (100) | 1.0 |
| Time to blood culture draw (min) | 135.0 (67.8–202.1) | 69.8 (47.9–91.7) | 0.07 |
| Proportion receiving antibiotics, *n* (%) | 24 (96.0) | 15 (88.2) | 0.34 |
| Time to antibiotic administration (min) | 218.8 (151.3–286.2) | 118.8 (87.9–149.7) | 0.009 |
| Proportion receiving fluid bolus, *n* (%) | 22 (88.0) | 17 (100) | 0.14 |
| Time to first fluid bolus (min) | 107.2 (67.2–147.3) | 63.4 (43.0–83.8) | 0.05 |

CI, confidence intervals; ICU, intensive care unit; SNAP, sepsis now a priority.

algorithm. We did not study ICU or hospital readmissions as balancing measures.

Our initial observational data was obtained using ICD-10-CA codes [20, 31]. We then applied our inclusion criteria to identify sepsis cases through chart review. While we felt our methodology was inclusive, ICD-10-CA coding is imperfect and there was potential for sepsis cases to be missed and for uncomplicated sepsis to be over-represented. This was a retrospective observational study and consequently, chart review involved some subjective interpretation. Our pre- and post-intervention data were unadjusted for confounders, which subjects our results to bias and may have influenced the outcomes observed. While pre- and post- intervention data was collected using different methodology, the algorithm criteria used for identification of sepsis in the post-intervention group closely approximated that of the pre-intervention group. We noted that in the post-intervention group if patients were found to have an alternate diagnosis and the care provider did not electronically terminate the sepsis protocol, they were included in our post-intervention data set. Based on the review of admission diagnoses, 10% of patients in the post-intervention group had no evidence of infection at the time of ED presentation. We did not include an analysis of overall hospital LOS or in-hospital mortality for this reason. LOS and mortality were only analyzed in the ICU subgroup, with individual chart review to ensure sepsis was present.

This was a single-center study, therefore our methods would require some adaptation if applied to other centers, specifically those not using electronic medical records or centers unfamiliar with order-sets. However, as mentioned above, the key elements of our study have now been shown to be reproducible, and therefore should be foci for similar future efforts.

Our study did not capture patients with sepsis who were not identified by the SNAP triage criteria. Further work is required to evaluate the diagnostic accuracy of our triage-based screening. We also recognize that increased awareness of sepsis over the past several years, as well as the global promotion of SSC guidelines, may have introduced bias, where some of our findings may be confounded by changes in practice independent of our protocol implementation. It is unlikely that this bias was a major contributor, as we noted statistically significant improvements in all process measures targeted by our protocol.

## Conclusion

Our study demonstrates that a triage-based early sepsis recognition protocol is effective at improving delivery of care to patients with sepsis in the ED. We significantly improved time to antibiotic administration and fluid resuscitation, both interventions that have been associated with improved outcomes in sepsis. We advocate that the SNAP protocol is an effective screening tool for all patients presenting to hospital with sepsis, and invite other institutions to consider our strategy to improve delivery of care.

## Supplementary material

Supplementary material is available at *International Journal for Quality in Health Care* online.

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