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Strengthening sepsis care at a tertiary care teaching hospital in New Delhi, India

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ABSTRACT

Introduction Failure of early identification of sepsis in the emergency department (ED) leads to significant delays in antibiotic administration which adversely affects patient outcomes.

Aim The primary objective of our Quality Improvement (QI) project was to reduce the door-to-antibiotic time (DTAT) by 30% from the preintervention in patients with suspected sepsis. Secondary objectives were to increase the blood culture collection rate by 30% from preintervention, investigate the predictors of improving DTAT and study the effect of these interventions on 24-hour in-hospital mortality.

Methods This QI project was conducted in the ED of a tertiary care teaching hospital of North India; the ED receives approximately 400 patients per day. Adult patients with suspected sepsis presenting to our ED were included in the study, between January 2019 and December 2020. The study was divided into three phases; preintervention phase (100 patients), intervention phase (100 patients) and postintervention phase (93 patients). DTAT and blood cultures prior to antibiotic administration was recorded for all patients. Blood culture yield and 24-hour in-hospital mortality were also recorded using standard data templates. Change ideas planned by the Sepsis QI Team were implemented after conducting plan-do-study-act cycles.

Results The median DTAT reduced from 155 min in preintervention phase to 78 min in postintervention phase. Drawing of blood cultures prior to antibiotic administration improved by 67%. Application of novel screening tool at triage was found to be an independent predictor of reduced DTAT.

Conclusion Our QI project identified the existing lacunae in implementation of the sepsis bundle which were dealt with in a stepwise manner. The sepsis screening tool and on-site training improved care of patients with sepsis. A similar approach can be used to deal with complex quality issues in other high-volume low-resource settings.

INTRODUCTION

Sepsis is a dysregulated host response to infection causing life-threatening organ dysfunction.[1] In 2017, around 11 million sepsis-related deaths have been reported worldwide with highest burden in low-income and middle-income countries (LMICs).[2] Surviving Sepsis Campaign (SSC) guidelines recommend the implementation of a 1-hour bundle for patients with sepsis to reduce morbidity and mortality.[3] The guidelines recommend sending blood cultures prior to antibiotics, administering antibiotic, starting appropriate fluid resuscitation, measuring lactate and starting inotropes if necessary within the first hour of recognising sepsis and septic shock. Nevertheless, the translation of evidence-based guidelines to clinical practice remains a challenge. Quality improvement (QI) initiatives in this field are much needed to bridge the 'know-do gap'. These initiatives conducted to improve patient safety have successfully been implemented in high-income countries (HICs). However, limited data are available regarding their impact on sepsis care in LMICs.[4]

The emergency department (ED) of our institution caters to 400 patients daily, with sepsis being the most common life-threatening emergency. Being a tertiary care academic centre located in a highly dense population zone of North India, our department caters to a large proportion of critically ill patients. Sepsis care in our high-volume, resource strapped setting was often found to be suboptimal by the staff. In an effort to promote patient safety and care, a QI initiative for sepsis patients was planned in ED. We intended to focus on implementing two most important aspects of the sepsis bundle that is, administering antibiotics within 1 hour of presentation to the ED and draw blood cultures prior to antibiotic administration.

The primary objective of our QI project was to reduce the door-to-antibiotic time (DTAT) by 30% from preintervention. Secondary objectives were to increase the blood culture collection rate by 30% from preintervention, investigate the predictors of improving DTAT ≤60 min and study the effect of these interventions on 24-hour in-hospital mortality.

METHODS

This study was conducted in the ED of a tertiary care teaching hospital of North India. The staff work in 6-hour shifts every day. In each shift, 20 residents are supported by a team of 30 nursing officers with one resident and one nursing staff posted at triage. Around 100 new patients are screened for emergency conditions in every shift.

Adult patients with suspected sepsis presenting to our ED were included in the study, from January 2019 to December 2020. Paediatric patients (<14 years age), and adult patients in cardiac arrest, patients presenting with trauma, patients with other life-threatening and time-sensitive conditions like airway obstruction, chest pain, seizures, stroke and anaphylaxis were excluded.

The quality of sepsis care was assessed by considering the DTAT and measuring the proportion of patients with blood cultures sent prior to antibiotic administration. DTAT was calculated from the time of patient arrival to triage and the time of antibiotic administration from patient case records. Information regarding blood cultures obtained before antibiotic administration was recorded using patient charts or online computer system. The study was divided into three phases, that is, preintervention, intervention and postintervention phase. Preintervention phase was from January 2019 to April 2019. During this period, preintervention data such as demographic and clinical details, DTAT, blood culture information and 24-hour in-hospital mortality among suspected sepsis patients were collected (data collection sheet in online supplemental material). Analysis of the preintervention data was conducted using fishbone analysis (online supplemental material) and process flow chart. Detailed process flow chart of suspected sepsis patients in our ED is depicted in figure 1. Intervention phase was from May 2019 to March 2020, wherein all the change ideas were tested using Plan-Do-Study-Act (PDSA) cycles and implemented if successfully tested (described in detail later). From September 2020 to December 2020, a postintervention phase was conducted and data collection similar to the preintervention phase was done. The COVID-19 pandemic had disrupted the data collection from April 2020 to August 2020, but after certain modifications we restarted the project.

A total of 100 patients were included in the preintervention phase (details in table 1). The DTAT was found to be 155 min with only 8% patients receiving antibiotics within 1 hour of arrival. No blood cultures were drawn prior to antibiotic administration for patients presenting

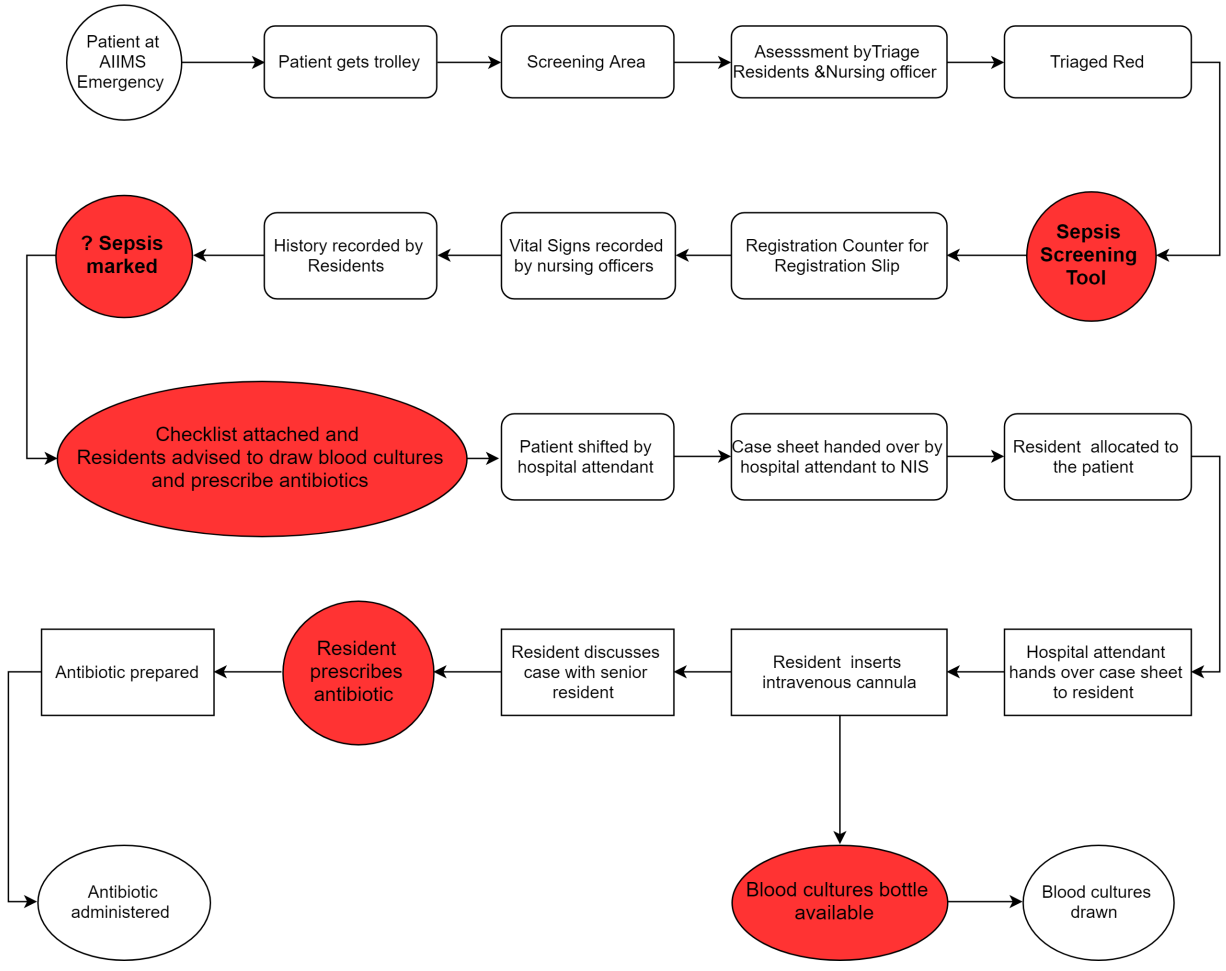

Figure 1 Emergency department sepsis flow map analysis. AIIMS, All India Institute of Medical Sciences; Red Patient, Patient who is prioritised in triage to be assessed early; NIS, Nurse Information Specialist.

Table 1 Characteristics of study population

Characteristics	Preintervention (n=100)	Intervention (n=100)	Postintervention (n=93)	Overall (n=293)
Dates	January 19–April 19	May 19–May 20	June 20–December 20	January 19–December 20
Age in years	45 (30–63)	42.5 (23–56.3)	51 (35–61.5)	45 (29–60)
Males, n (%)	67 (67)	65 (65%)	55 (59)	187 (63.8)
Triage as red, n (%)	89 (89)	98 (98)	90 (97)	277 (94.5)
Source of sepsis, n (%)				
Abdominal	18 (18)	31 (31)	11 (11.8)	60 (20.5)
Cellulitis	3 (3)	4 (4)	8 (8.6)	15 (5.1)
Central Nervous System infections	11 (11)	1 (1)	8 (8.6)	20 (6.8)
Others	11 (11)	18 (18)	12 (12.9)	41 (14)
Respiratory tract	51 (51)	45 (45)	48 (51.6)	144 (49.1)
Urogenital tract	6 (6)	1 (1)	6 (6.5)	13 (4.4)
Number of comorbidities				
None	26 (26)	50 (50)	30 (32.3)	106 (36.2)
One	59 (59)	45 (45)	45 (48.4)	149 (50.9)
Two	12 (12)	2 (2)	14 (15.1)	28 (9.6)
More than two	3 (3)	3 (3)	4 (4.3)	10 (3.4)
Presenting vitals				
Heart rate, per min	112 (89–127)	121 (109–134)	100 (90–130)	113 (90–130)
Systolic Blood Pressure, mm Hg	110 (84–134)	90 (80–99)	112 (91–138)	100 (85–126)
Oxygen saturation, %	92 (84–98)	97 (94–98)	96 (87–98)	96 (89–98)
Respiratory Rate, per min	22 (20–26)	20 (20–23)	26 (22–28)	22 (20–26)
Glasgow Coma Score (GCS)	15 (12–15)	15 (15–15)	15 (12–15)	15 (13–15)
Sepsis screening tool applied, n (%)*	0 (0)	61 (61)	48 (51.6)	109 (37.2)
Blood cultures collected, n (%)*	0 (0)	17 (17)	63 (67.7)	80 (27.3)
Door to antibiotic time*	155 (92–438)	118.5 (73.8–221.8)	78 (54–122.8)	115 (70–202)
Door to antibiotic time less than 60 mins, n (%)*	8 (8)	13 (13)	34 (36.6)	55 (18.8)
24-hour mortality, n (%)*†	23 (31.5)	7 (19.4)	4 (7.8)	34 (21.3)

*P<0.05 (for difference in all three groups).
†Information provided was for the patients (total=160) who could be followed up.

with suspected sepsis during this phase. The 24-hour in-hospital mortality rate was found to be 23%.

INTERVENTIONS

Sepsis QI team formation

The WHO Point-of-Care Quality Improvement model was used.[5] A multifaceted team consisting of faculty in emergency medicine, resident doctors, nursing officers and allied healthcare workers of the ED was formed (figure 2). The team was led by a resident doctor and mentored by the faculty. The QI team members met at least once every 2 weeks.

Process flow charts (figure 1) and fishbone analysis (online supplemental figure 1) were used to identify gaps in care. Based on the causes identified in the analysis, the team came up with change ideas. The change ideas were tested using the PDSAs. Change ideas were first tried for a short time and on a small scale to learn if they were feasible. Changes that were feasible to do in the given context and had the potential to achieve the goals

Figure 2 Photographs of quality improvement (QI) team, on-site QI training and QI meeting.

defined were implemented. Timewise implementation of change ideas is presented in figure 3. A data collection team was formed within the study team and included the nursing staff posted in triage. They were asked to note the patient's arrival time (T1) to triage in an anonymous manner on a small data collection sheet and share the copy of the data sheet on a small closed WhatsApp group that was formed. The nursing staff in-charge of electronic health records (EHR) posted inside the ED would then identify these patients during their rounds and add the antibiotic administration time from the case notes of the patient as T2. The times were then noted on a data collection sheet present with this staff. The data in-charge routinely collected information from the other team members and updated in the excel sheet.

PDSA-1 National Early Warning Score for Sepsis Screening Tool at triage

To achieve compliance with administration of antibiotics within 1-hour, recognising sepsis at triage was the major bottleneck identified. For this purpose, a screening tool for suspecting sepsis in a patient was needed. Of the preexisting screening tools, quick Sequential Organ Failure Assessment (qSOFA) score was rejected by consensus as it is non-specific and had more utility as a mortality predictor in Intensive Care Unit (ICU) settings.[6–8] Considering the sensitivity of National Early Warning Score (NEWS) in identifying Sepsis,[9] NEWS was tried as a screening tool in our ED from 6 May 2019 to 13 May 2019. The NEWS score was found to be tedious as it required calculating the score every time. During the busy hours in triage the front-line staff often found it challenging to use this score and hence it was abandoned.

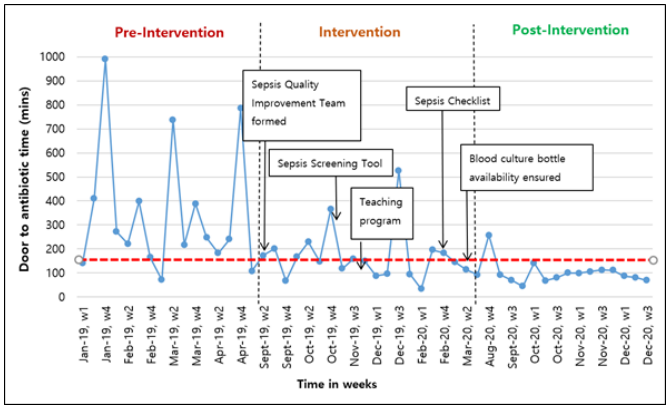

Figure 3 Run chart of the quality improvement project, depicting the weekwise door to antibiotic time (in minutes), stretching over all the three phases of the study. January-19, w1 denotes first week of the month January 2019 (similar notion applies to all the data points in x-axis).

PDSA 2: On-site teaching and awareness

We had learnt from our earlier experiences that classroom teaching often failed due to poor attendance. This was largely due to shift duties of the emergency staff.[10] On 15 October 2019, we did our first PDSA (onsite awareness and training to identify sepsis) wherein we started on-site training for nurses and residents working in triage. The training was planned in the early hours of the shift between 7:00 and 8:00 hour to allow ample time with residents and nurses as the patient load was scarce. The training was easy to perform, lasting only 10–15 min each time and simple to replicate. We got a positive response from the front-line staff. A total of five training sessions were conducted and all staff members working in triage were included. The sessions were led by residents and nursing officers regularly working in triage. The data on DTAT was recorded continuously on these days, but we did not expect to see any improvement in this regard, as the team in the treatment area of the emergency was not involved in training.

PDSA 3: Implementation of a 'Sepsis Screening Tool'

In view of the specific challenge of lack of a sepsis screening tool, we devised a novel tool specifically for utility in our ED. The existing AIIMS Triage Protocol[11] was modified to include triage clinical features of infection (tCFI),[7 12] to form a novel 'AIIMS Sepsis Screening Tool (SST)' (details in online supplemental figure 2). The AIIMS SST was developed using the Delphi method. The SST was tried in a PDSA cycle conducted between 22 October 2019 and 29 October 2019 and was adopted successfully by the triage staff. The triage staff and residents were asked to highlight 'Suspected sepsis' or '? Sepsis' on the patient record paper at the triage desk. The doctors and nurses in triage were encouraged to apply the novel SST during their respective morning shifts. DTAT was continuously being recorded. The clinical process was tested during five morning shifts and the front-line staff found it straightforward to use and easy to integrate into the current system of triage. Due to the large number of doctors and nurses on rotating and changing shifts at any point of the day, it was not possible to train all concerned stakeholders at the same time. Thus, we decided to focus on different areas of the department one by one. With the success of this change idea in the morning shift, we decided to test it on a larger scale. Starting 31 October 2019, this new clinical process was implemented in all shifts.

PDSA-4: Regular teaching and awareness sessions

Residents and nursing staff posted in the triage area and ED floor had regular on-site training sessions organised in October and November 2019. Short on-site training sessions were organised for the staff and residents before morning shift started. They were briefed regarding the importance and implementation of 1-hour sepsis bundle for patients presenting with suspected sepsis.

In view of change in the ED staff due to the COVID-19 pandemic, the teaching programme was incorporated in the weekly academic activities of the department in September and October 2020.

PDSA 5: Sepsis checklist

In February 2020, a sepsis checklist highlighting the important aspects of the 1-hour sepsis bundle was introduced. This checklist was required to be attached to the case sheet of patients presenting with suspected sepsis. Due to COVID-19 pandemic, the checklist was abandoned to decrease virus transmission by fomites. Following this, the triage team was instructed to mention 'prescription of appropriate antibiotics and blood cultures to be drawn prior to antibiotic administration' in all case sheets highlighted as Suspected Sepsis.

PDSA 6: Ensuring blood culture bottle availability

Regular stocking and availability of blood culture bottles was identified as a major bottleneck for drawing blood cultures prior to antibiotic administration. During the intervention phase, efforts were made to ensure a regular supply of blood culture bottles. The standard operating procedures (SOPs) in our ED specified replacement of blood culture bottles after furnishing records of bottles used in the department. The stock of blood culture bottles was replenished only after the existing stock was exhausted. There were significant delays in replenishing the exhausted stock and despite our best efforts the delays could not be minimised. This problem continued to plague our system throughout the intervention phase, therefore a significant improvement in blood culture rates was not discernible. In September 2020, a meeting was organised with the Department of Microbiology to change the existing SOP. It was decided that the ED would be provided with a steady supply of culture bottles irrespective of the existing stock. After seeking due cooperation from the Department of Microbiology, a hospital attendant was entrusted with the responsibility to ensure regular stock of blood culture bottles in the ED.

The COVID-19 pandemic presented unprecedented challenges for our QI project. Restructuring of triage area, reshuffling of triage staff and difficulty in conducting team meetings due to social distancing norms resulted in halting of this QI project from April 2020 to August 2020. But the project gained momentum later with the advantage of data collection from a separate screening area for influenza-like illness patients.

Data collection and analysis

Time of arrival to ED of suspected sepsis patients was noted on the case sheet along with vitals and chief complaints on presentation. Time of first antibiotic administration was noted from the patient case notes after the patient was shifted to the treatment area. DTAT was calculated from the above-mentioned time stamps. Blood cultures drawn prior to antibiotic administration were recorded by the data collection team from the details mentioned regarding the same in the patient case sheets. This information was collected and reviewed by the members of the QI team weekly. Interrupted time series charts were made to see the effect of PDSAs. Probability based rules of run charts were applied on the interrupted time series chart to investigate the non-random variations.[13] Quantitative variables were tested for normality using Kolmogorov-Smirnov test. Normally distributed quantitative variables were expressed as mean and SD. Non-normally distributed variables were expressed as median and IQR. Categorical variables were summarised as frequency (%). Data analysis was done in IBM SPSS Statistics for Windows, V.27 (IBM). A $p<0.05$ was considered statistically significant.

Patient and Public Involvement

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

RESULTS

Population description

Our study was conducted over 2 years, starting from January 2019 to December 2020. A total of 100, 100 and 93 suspected sepsis patients were included in the preintervention, intervention and postintervention phase, respectively. Detailed population characteristics were described in table 1. Overall, the study population had a median age of 45 years and 63.8% were males. Respiratory tract infections were the the most common suspected source of sepsis among our patients. Nearly half of the cohort had one comorbidity.

Effect of interventions on reducing the DTAT

The effects of all the PDSAs were depicted using a time series chart (figure 3). The median DTAT in the preintervention phase, that is, 155 min, was taken as the chart's centre line to see the effect of various PDSAs. Applying the run chart's probability-based rules (12), it was found that there was a shift of data points from above the median line (January and February 2019) to below it (October, November and December 2020). Downward trend in DTAT was noted in November and December 2020 data points. Too few runs (ie, 18 which was below the cut-off of 20) were found, suggesting a non-random variation (ie, real change). Effect of the interventions was also shown in figure 4. The median DTAT (IQR) in preintervention phase was 155 min (92 – 438), intervention phase was 118.5 (73.8–221.8) and postintervention phase was 78 (54–122.8).

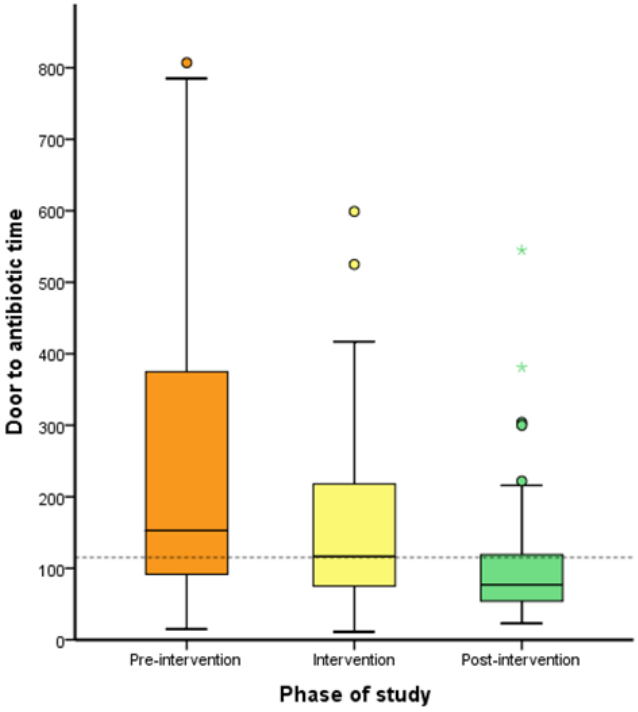

Figure 4 Box-whisker plot showing the comparison of median door to antibiotic time in three phases of the study. Kruskal-Wallis H test's p value was <0.001. Median door to antibiotic time here in each phase is the median of all the data points in the respective phase which are preintervention, intervention and postintervention phase.

Predictors of 'DTAT ≤60 min'

Proportion of patients receiving antibiotics within 60 min of arrival had improved from 8% (8 of 100 patients) in preintervention phase to 36.6% (34 of 93 patients) in postintervention phase. Adjusted OR of all the predictors of DTAT <60 min are presented in online supplemental table 1. We found that the covariates like patients with fever (OR: 3.03), altered sensorium (OR: 4.55), lower GCS (OR: 1.2), application of sepsis screening tool (OR: 4.41) and patients in postintervention phase as compared with those in preintervention phase (OR: 4.75) were found to be statistically significant predictors (p<0.05) (figure 5).

Effect of interventions on increasing the blood culture collection rate

In the preintervention phase, blood culture collection rate was zero percent. As the PDSA-5 was introduced in the intervention phase, blood collection rate increased to 17% (17 out of 100 patients); which further increased to 67.7% (63 out of 93 patients) in the postintervention phase (p<0.001) (figure 6). Adjusted OR of all the predictors of 'blood culture collection' were presented in online supplemental table 2. Similar to the predictors of DTAT ≤60 min, application of sepsis screening tool and patients in postintervention phase had led to significant increase in odds of blood cultures collection in our ED.

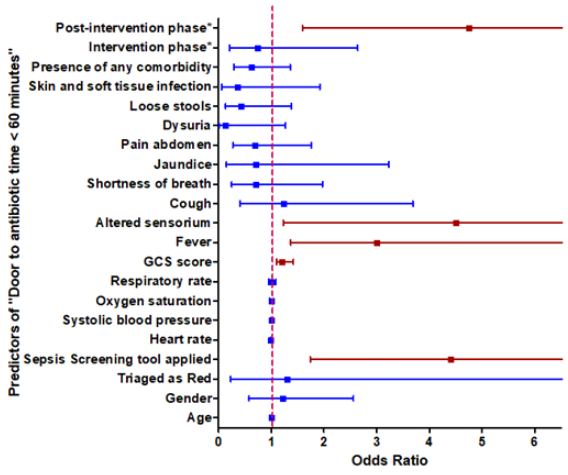

Figure 5 Adjusted OR of all the predictors of 'Door to antibiotic time <60 min'. Predictors with red colour bar had a statistically significant OR (p<0.05). Predictors with blue colour bar crossing the null value (red dashed line) were not significant covariates. '*' indicates comparison of door to antibiotic time with the pre-intervention phase.

Effect of interventions on reduction of 24-hour crude mortality rate

For 24-hour in-hospital mortality, patients were followed up but 133 out of 293 patients were transferred to other hospitals. Among the patients (n=160) who could be followed up, overall, 24-hour mortality was 21.3% (34 out of 160). The crude mortality rate significantly reduced (p<0.05) from 23% in the preintervention phase to 4% in the postintervention phase (table 1).

DISCUSSION

This QI project attempts to highlight the impact of a QI initiative to improve sepsis care in a high-volume ED. The key focus of the project was to come up with a sustainable

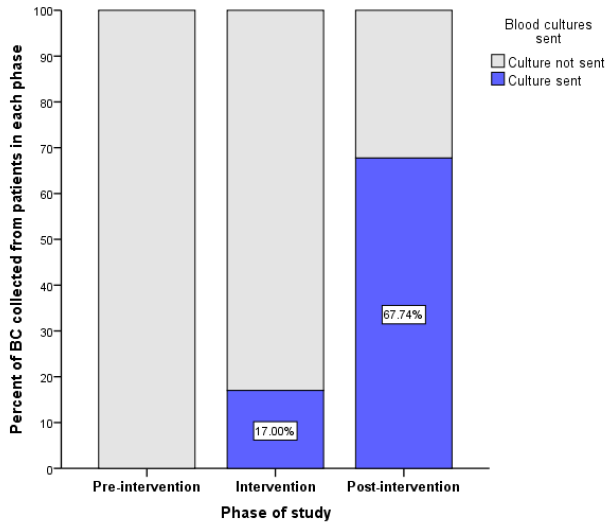

Figure 6 Phasewise proportion of patients with blood culture collected prior to antibiotics administration. BC, blood culture.

solution to the problem rather than a short-term intervention. This initiative is one among few to be set in LMICs. Our study underscores the value of incorporating simple measures viz. using a sepsis screening tool and regular on-site teaching and training without incurring any additional cost. All change ideas were implemented after conducting PDSA cycles which ensured their acceptance by the healthcare workers. Due consideration was given to avoid any cumbersome change ideas as found by the team.

No major costs were incurred during conduct of this project. No equipment was procured, no additional staff were recruited and no construction was undertaken in the existing hospital building. The focus, instead, was on changing processes of care to make it easier for residents and staff to adhere to components of the 1-hour sepsis bundle.

Reduction in DTAT was found to be statistically significant. There was an increase in the rate of blood cultures drawn prior to antibiotic administration from 0% in the preintervention phase to 68% in the postintervention phase. Increased compliance with sepsis bundle showed a direct correlation with clinical outcomes as was demonstrated by reduction in mortality. The 24-hour mortality although statistically different between preintervention and postintervention groups is prone to bias because significant cohort of patients were transferred to other hospitals.

Previous studies on QI initiatives in sepsis patients showed significant improvement in practice after implementation of change ideas.[12 14–19] Most of these studies were conducted in HICs, used laboratory parameters to recognise sepsis and had the provision for electronic medical records. Our study differs in the critical aspect as being one of its kind to be conducted in a high-volume, low-resource setting. As part of this QI effort, data were collated from different sites in the ED.

Our sepsis QI team included all staff members involved in patient care viz. consultants, residents, nursing officers and hospital attendants. Each team member enlisted the issues faced in patient care from their unique perspective and helped in establishing an efficient data collection technique over a period of 2 years.

Sepsis Screening Tool implementation was found to be associated with improved compliance with drawing blood cultures and antibiotic administration within 1 hour. As a clinical outcome, direct correlation with mortality reduction was demonstrated. Conventional sepsis screening tools were found unsuitable for our settings. qSOFA was less sensitive causing over-triage and NEWS was cumbersome to implement.[6–9] AIIMS triage protocol was modified to look for tCFI in patients triaged RED as per criteria of altered physiology. It was readily accepted by the residents and staff posted in triage since this was a part of our existing protocol. This showcased the fact that in a high-volume setting with a constantly changing resident and staff population, efforts to modify the existing system prove more sustainable than convincing healthcare workers to embrace an unfamiliar system. Our experience shows that QI projects in resource-constrained settings are better applicable for individual components of a care bundle rather than all at once.

Short on-site teaching and training sessions were instrumental in spreading awareness and motivating front-line staff. ED differs from other departments in having a shift work culture. A problem in the teaching programme was to find a common time and place to gather staff. This issue was overcome by short and crisp on-site and on-duty teaching sessions which were conducive to our settings.

Significant delay was noted in improving blood culture rates prior to antibiotic administration. The delay was partly attributable to the existing SOP for procuring blood culture bottles for the ED. This problem was solved with due cooperation from the Department of Microbiology, thereby emphasising the role of interdepartmental cooperation to improve patient care. Increasing blood culture rates prior to antibiotic administration should improve blood culture yield rates. This in the long run will assist the development of department-specific antibiogram contributing to an antibiotic stewardship programme.

This project has brought about better implementation of sepsis bundle in a busy ED. Biannual on-site training sessions have been initiated along with inclusion of sepsis screening tool in a teaching manual for newly joined residents of the department. The momentum attained by our project will be carried on by two new projects planned in the ED, one being validation of the novel sepsis screening tool and the other being improving the blood culture positivity rate. To ensure that the improvements are sustained, periodic audits by the QI team will be conducted.

There were certain limitations to our study. In our QI initiative, only two components of the Surviving Sepsis guidelines were taken into consideration. Our project included patients presenting with suspected sepsis at triage, leaving out patients developing sepsis after arrival to ED. Collection of DTAT during our QI project was by forming a WhatsApp group with data being collected by the QI team members, which appears to be tedious. For future activities in the department, we have planned to collect this data from the ED EHR. We are planning to select the patients with '? Sepsis' diagnosis, retrieve the T1 (time of admission to ED) and T2 (administration of first dose of antibiotics as recorded by the nursing staff) and calculate DTAT. Further initiatives would be required for other components, that is, time to start inotropes and lactate clearance. The novel screening tool used in this project has not been validated earlier. As the implementation of well validated qSOFA and NEWS scores were failed in PDSAs, we developed the novel sepsis screening tool using Delphi method. The tool has to be prospectively validated internally and externally in future studies.

Yield rates would increase with the improvement in the technique of obtaining blood cultures, which was not included in our study. In view of COVID-19 pandemic, restructuring of triage and segregation of patients with

respiratory infection may be a confounding factor for reduced DTAT in postintervention phase. Although the improvement in blood culture rates and proportion of patients receiving antibiotics within an hour has surely improved, the standard of sepsis care is still suboptimal. Important factors preventing an optimal outcome were found to be regular change of staff and a large cohort of untrained residents and staff employed in the ED. Regular teaching initiatives by the department would help sustain this improvement and achieve the highest possible standards in patient care in the future.

CONCLUSION

Streamlining sepsis care is essential in all EDs as sepsis is a life-threatening and time-sensitive condition. This QI initiative helped in successful implementation of the two main components of the SSC bundle. Fever, altered sensorium and application of sepsis screening tool were independent predictors of reduced DTAT. The crude mortality rate significantly reduced in the postintervention phase when compared with the preintervention group. New SOP to procure blood culture bottles helped in improving the blood culture rates. On-site training sessions were key in spreading awareness and engaging with front-line staff.

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Patient consent for publication Not required.

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Supplementary materials

1. Supplementary Table – 1: Adjusted odds ratio of predictors of 'door to antibiotics time ≤ 60 minutes'
2. Supplementary Table – 2: Adjusted odds ratio of predictors of 'Collection of blood culture'
3. Supplement Figure – 1: Fish bone analysis
4. Supplement Figure – 2: Sepsis screening tool

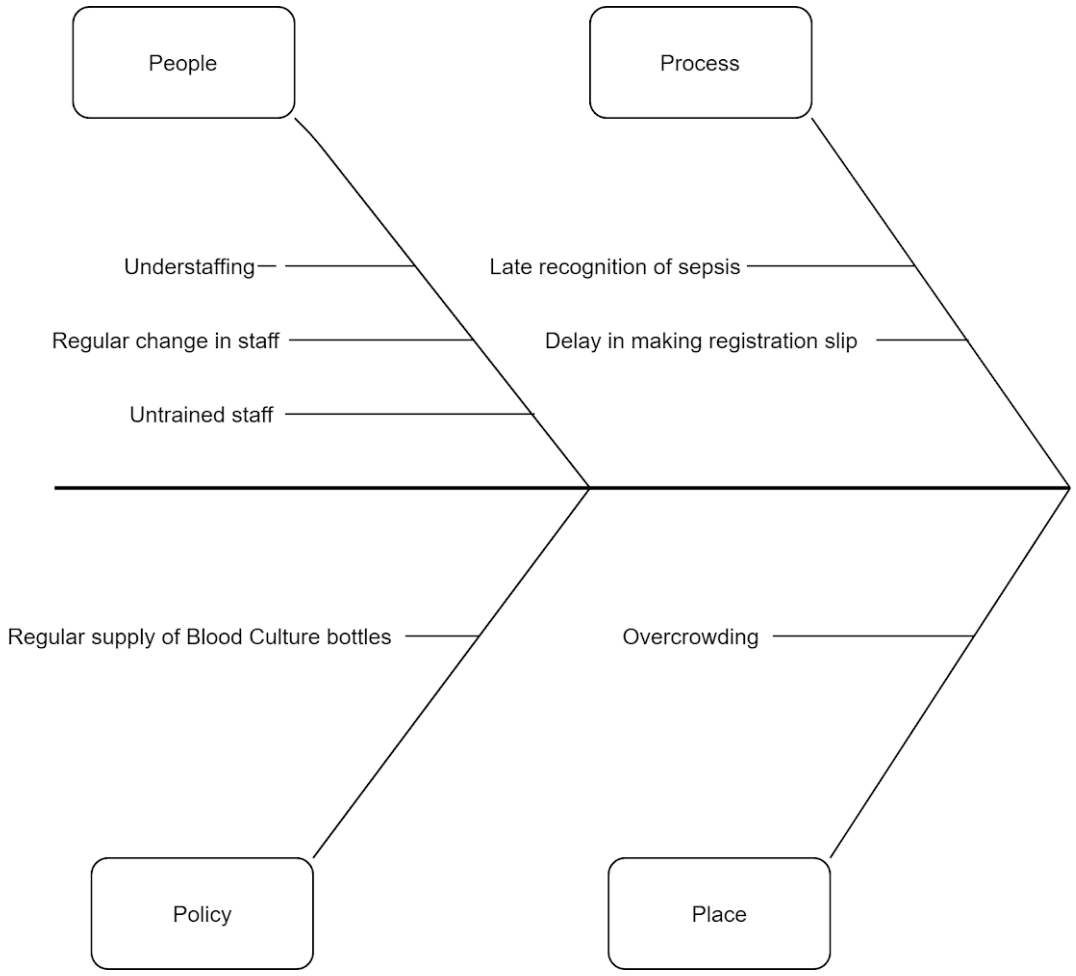
Supplementary Table – 1: Adjusted odds ratio of predictors of 'door to antibiotics time ≤ 60 minutes'

Characteristics	LCI	OR	UCI	p-value
Age	0.98	1.00	1.02	0.76
Gender	0.58	1.22	2.56	0.60
Triaged as Red	0.23	1.30	7.37	0.77
Sepsis Screening tool applied	1.74	4.41	11.16	0.00
Heart rate	0.98	0.99	1.01	0.47
Systolic blood pressure	0.99	1.00	1.01	0.83
Oxygen saturation	0.97	1.00	1.04	0.81
Respiratory rate	0.95	1.02	1.09	0.58
GCS score	1.02	1.2	1.42	0.03
Fever	1.36	3.03	6.73	0.01
Altered sensorium	1.23	4.55	16.82	0.02
Cough	0.41	1.23	3.69	0.71
Shortness of breath	0.25	0.70	1.97	0.50
Jaundice	0.15	0.70	3.23	0.65
Pain abdomen	0.27	0.69	1.76	0.44
Dysuria	0.01	0.12	1.27	0.08
Loose stools	0.13	0.43	1.38	0.15
Skin and soft tissue infection	0.06	0.35	1.92	0.23
Presence of any comorbidity	0.29	0.63	1.36	0.24
Intervention phase*	0.21	0.74	2.64	0.64
Post-intervention phase*	1.59	4.75	14.16	0.01

Supplementary Table – 2: Adjusted odds ratio of predictors of 'Collection of blood culture'

	Sig.	aOR	95% C.I.for aOR	
			Lower	Upper
Age	.551	.991	.963	1.020
Sex(1)	.893	.938	.366	2.401
Triage(1)	.026	10.824	1.325	88.427
SepsisScreeningtoolapplied(1)	.000	71.920	13.292	389.132
HR	.371	1.009	.989	1.029
SBP	.361	1.008	.991	1.026
Sp02	.330	1.019	.981	1.060
RR	.216	.944	.862	1.034
GCS	.505	.918	.714	1.181
Fever(1)	.082	3.068	.867	10.847
Alteredsensorium(1)	.220	.368	.074	1.818
Cough(1)	.585	1.476	.365	5.967
Shortnessofbreath(1)	.820	1.159	.326	4.117
Jaundice(1)	.138	.171	.017	1.759
Painabdomen(1)	.927	.945	.281	3.182
Dysuria(1)	.087	.135	.013	1.343
Loosestools(1)	.588	.647	.134	3.121
Skinandsofttissueinfection(1)	.001	.024	.002	.231
comoribidity_present(1)	.522	1.409	.493	4.027
Intervention_phase(1)	.000	346.577	52.898	2270.689

Supplement Figure – 1: Fish bone analysis



Supplement Figure – 2: Sepsis screening tool

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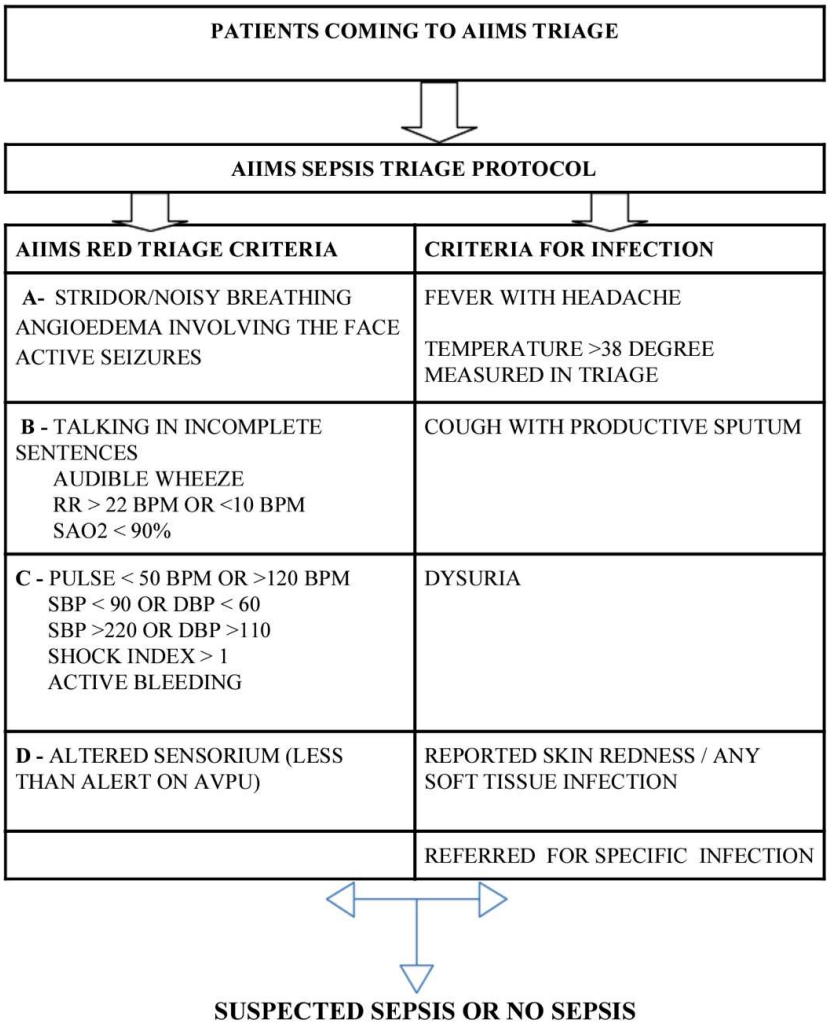

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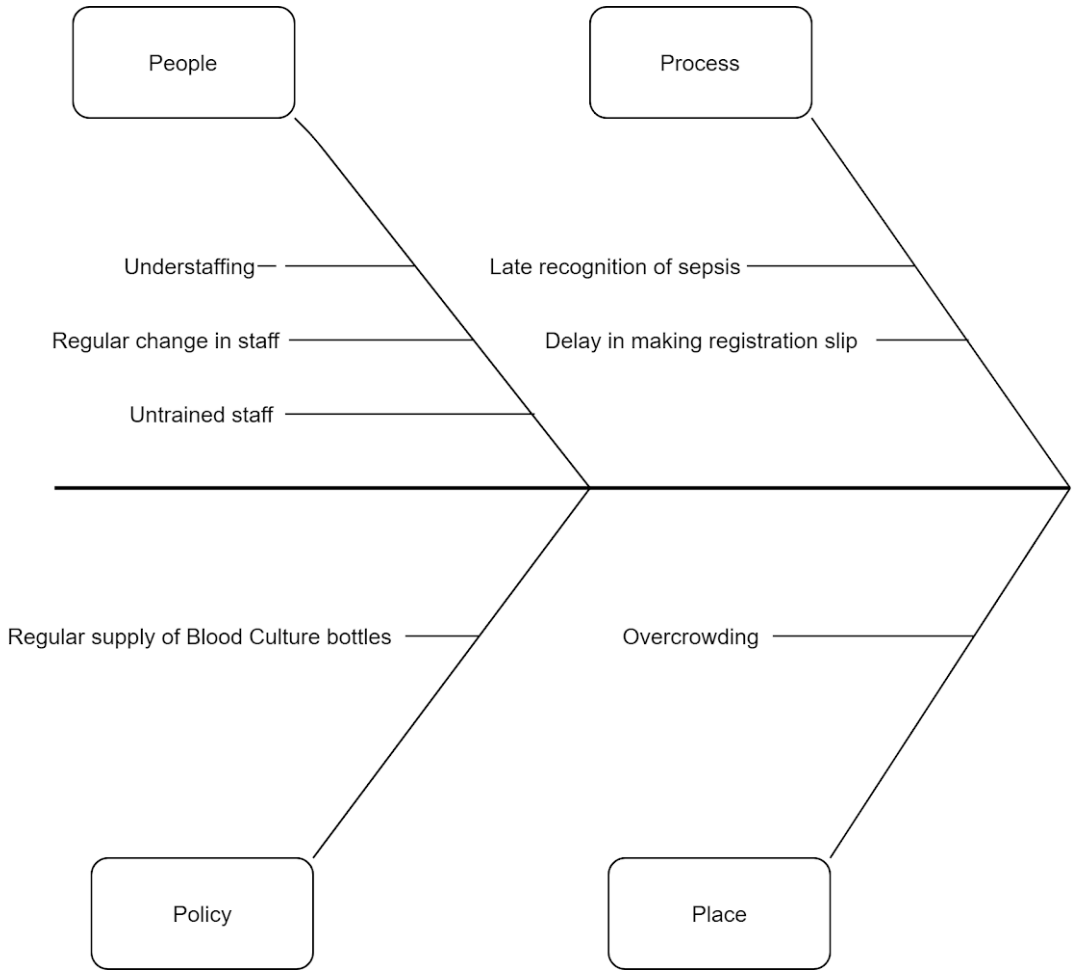

Supplement Figure – 2: Sepsis screening tool

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