# Fast Track Alert System Timer (FAST): Reducing time to antibiotics for septic patients in the emergency department

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***Abstract***

INTRODUCTION – Timely antibiotic administration in sepsis patients is critical in reducing mortality. Many studies apply the alert system or timer to alert care team members to improve time in each care process. This study aims to evaluate the impact of the timer countdown on Time to antibiotic in septic patients.

METHODS – This study is a prospective cohort study, collecting data between April 2023 and September 2023 in the ED of a tertiary care hospital. By comparing the pre and post-implementation process (3 months each), the primary outcome is Time to antibiotic, and the secondary outcome is the Mortality rate.

RESULTS – Comparing the average Time to antibiotics, the pre-implementation process time is 54 minutes (SD=35.6), and the post-implementation process time is 34 minutes (SD=19.5) (p= 0.0315). The in-hospital mortality rate is significantly improved in the Post-implementation group compared to the Pre-implementation group, with average mortality rates of 29% and 45% (p= 0.029), respectively.

CONCLUSION – Fast track Alert System Timer can improve the Time to antibiotic in septic patients. This study outlines an easy-to-implement, low-cost solution for emergency departments looking to shorten the Time to antibiotic.

***Keywords:*** Sepsis; Septic shock; Antibiotic; Time to antibiotic; Timer; Countdown; Mortality rate

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## *INTRODUCTION*

Sepsis is a clinical syndrome of life-threatening organ dysfunction caused by a dysregulated host response to infection[1]. Due to its high mortality rate, sepsis has drawn increased attention in diagnosis and management over the past 30 years. Despite this increasing attention, sepsis continues to have a high mortality rate[2], averaging 39% worldwide. Early detection of septic patients and aggressive treatment can improve patient outcomes[3]. Early antibiotic use, in particular, seems to reduce the mortality rate from sepsis and the progression of septic shock[4].

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A study by Yunjoo Im et al.[5], published in 2022, compared the in-hospital mortality of septic patients who had received antibiotics within 1 hour to those who did not. The study found that the adjusted OR for in-hospital mortality of patients whose time-to- antibiotics was within 1 hour was 0.78 and showed a 35% increased risk of mortality for every 1-hour delay in antibiotics.

Process Redesign of suspected septic patients in ED can shorten the Time to antibiotic[6]. Many studies compare the effectiveness of a pre-and post-implementation of an automated alert syste[7] In 2018, a study performed by Jung, A. D. et al. utilized a visual sepsis screen score, a bedside display equipped with a bedside clinical surveillance visualization, can hasten antibiotic administration (55.3 ± 15.5 h versus 16.2 ± 9.2 h; $P < 0.05$) and decrease the length of stay ($P < 0.01$) in surgical intensive care unit patients.

Many literatures assess the utility of automated alerting systems in sepsis. However, most of these studies assessed the alerting system's diagnostic accuracy in predicting sepsis[8],[9],[10], and just a few assessed its usefulness in clinically significant outcomes, such as mortality. In 2020, The systematic review by Hwang et al.[11], which included the study from 2009-2018, found that algorithm-based methods showed some evidence for improved process-of-care markers, including improved Time to antibiotic. Length of stay improved in two studies. One low-quality study showed animproved mortality rate.

In this study, we compared the previous care process with no alert system (Pre-implementation period) for suspected septic patients in the ED and the new care process (Post-implementation period), which includes the implementation of the Fast track Alert System (FAST), which countdowns time from patient arrival to the time that patient gets an antibiotic.

## METHODS

This study is a prospective cohort study, collecting data between April 2023 and September 2023 in the ED of Pranangklao Hospital, a tertiary care hospital in Nonthaburi, Thailand, following approval by the Ethics Committee of Pranangklao Hospital (PE6650). The Pre-implementation period was performed for three months between April and June 2023, and the Post-implementation period was also conducted for three months between July and September 2023.

The Fast track Alert System Timer (FAST) is the timer that countdowns the time from when the patient enters the ED to when the patient receives an antibiotic. The countdown starts when the eligible patient registers to the ED and has the Search out severity score or SOS score, calculated from initial vital signs, more than 3, which is shown to have a high mortality rate in septic patients[12]. FAST is displayed on a 55-inch display in the Resuscitation area in the Emergency Department directly in front of the nurse counter. The system is activated by the screening nurse at the triage area of the ED. A physician on duty then promptly examines the patient; if the physician's provisional diagnosis is sepsis, the intravenous (IV) antibiotic will be ordered and sent to the hospital pharmacy. When the antibiotic is dispensed, the nurse checks and administers it to the patient; all of the laboratory requested by the physician is drawn before it is administered. The timer is stopped when the first drop of Intravenous antibiotic is given to the patient, and the time is automatically recorded to the sepsis registry system for analysis. The recorded time includes: 1. Waiting time is the patient's waiting duration to be examined by a physician; 2. Physician Examination and Diagnosis Time is the duration that a physician examines, makes the diagnosis, and orders the antibiotic via the hospital information system; 3. Dispensing time is the duration between the time that the physician orders the antibiotic and the hospital pharmacy dispenses the antibiotic to the nurse; 4. Administration time is the duration between the nurse receiving the antibiotic from the hospital pharmacy and the patient being administered the antibiotic. The in-charge nurse is responsible for clicking the record button when completing each process.

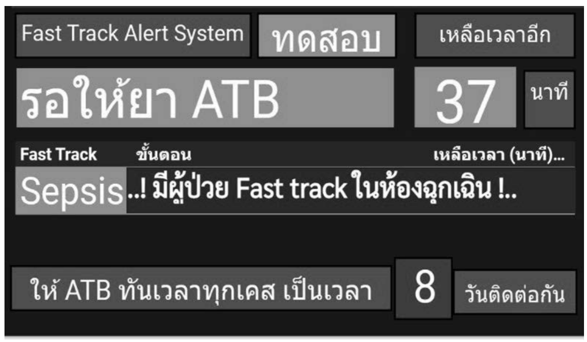



*Figure 1 The Alert system display a countdown time which translated to "Wait to administered ATB (Antibiotic)" and "Time left 37 minutes". The lowest red strip is an additional function of FAST called "Days without a delayed antibiotic" which displays the number of days from the last delayed antibiotic occurred, in this case, 8 days.*

## DATA COLLECTION

Data collection comprises Patient demographic data, presenting symptoms, vital signs, Glasgow coma scale (GCS), Diagnosis, site of infection, SOS score, duration of each process, and In-hospital mortality. The sepsis diagnosis is made by the emergency physician on duty. The Primary outcome is Time to antibiotic, while the secondary outcome is the In-hospital mortality rate.

## SAMPLE SIZE CALCULATION

We calculated the sample size for this study by using the equation N = $Z_{\alpha/2}^2 p(1-p)/d^2$ with the standard normal variate $(Z_{\alpha/2})$ at 5%, the probability of expected sensitivity (p) equals 0.9. A two-sided test concluded that the minimum sample size would be 139 samples. The mortality rate for sepsis is 39%, as reported in a previous study[13].

### STATISTICAL ANALYSIS

We compared the pre- and Post-implementation groups using the chi-square or Fisher's exact test for categorical variables and the t-test for continuous variables. The data was presented as a percentage for categorical data and as a mean with standard deviation or median with interquartile range, as appropriate, for numerical data. A p-value less than 0.05 was considered significant. We used STATA version 16.1 for statistical analysis (StataCorp LLC, College Station, TX).


*Figure 2 55-inch display in the Resuscitation area of the Emergency Department*

*Table 1 SOS score*

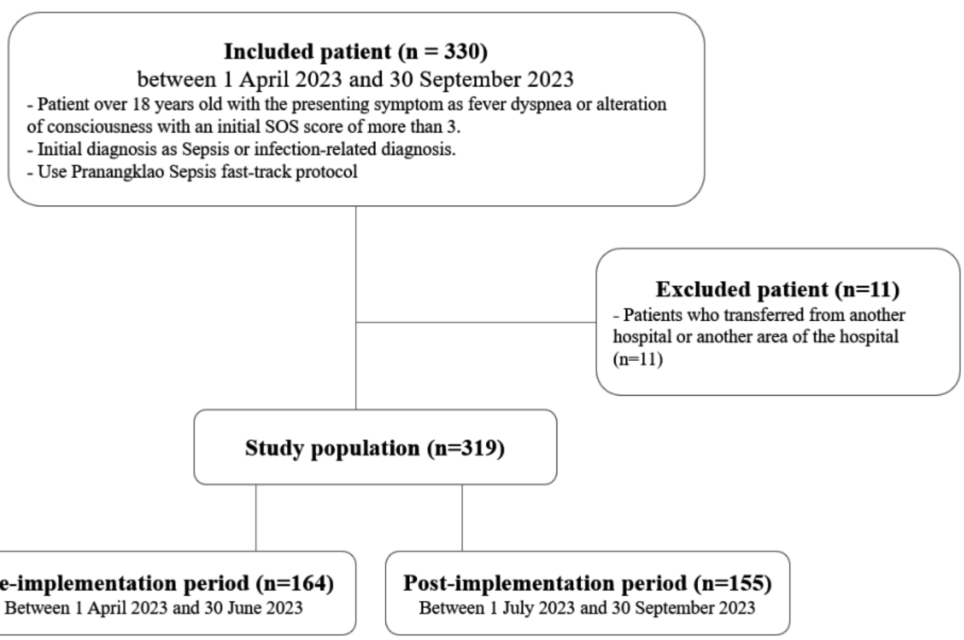
| SOS score | | | | | | | |
|---|---|---|---|---|---|---|---|
| Scores | RR | SpO2 | Temp | SBP | HR | Mental status | Urine |
| 3 | ≤8 | | | ≤80 | ≤40 | | |
| 2 | On ventilator | | ≤35 | 81-90 | | | ≤500 ml/d |
| 1 | | | 35+1-36 | 91-100 | 41-50 | Confusion/Agitation | 501-999 ml/d |
| 0 | 9-20 | N/A | 36.1-38 | 101-180 | 51-100 | Alert | ≥1000 ml/d |
| 1 | 21-25 | | 38.1-38.4 | 181-199 | 101-120 | Response to voice | |
| 2 | 26-35 | | ≥38.5 | ≥200 | 121-138 | Response to pain | |
| 3 | ≥35 | | | On vasopressor | ≥140 | Unresponsive | |

Inclusion criteria

- Patient over 18 years old with the presenting symptom as fever dyspnea or alteration of consciousness with an initial SOS score of more than 3.
- Initial diagnosis as Sepsis or infection-related diagnosis.
- Use Pranangklao Sepsis fast-track protocol

Exclusion criteria

- Patients who transferred from another hospital or another area of the hospital
- Pregnancy



## RESULTS

Between April 2023 and September 2023, 330 septic patients presented to the Emergency Department, 11 patients were excluded due to transferal from another area of the hospital, 319 patients were prospectively enrolled in the study, including 164 patients in the pre-implementation period, and 155 patients in post-implementation period. The overall mortality is 121 patients (38%)

Demographics include a median age of 66 and a median SOS Score of 6 (IQR 4-8). The most common source of infection is Pneumonia (43.3%), urinary tract infection (12.2%), and Gastrointestinal (10.7%). The percentage of septic shock patients is 32.3%. Comparing the pre and post-implementation process, no significant differences were observed in the number of patients, age, gender, source of infection, percentage of septic shock, and type of admission.

To compare the average Time to antibiotics, the pre-implementation process time is 54 minutes (SD=35.6), and the post-implementation process time is 34 minutes (SD=19.5) (p= 0.0315). The average time in each process is significantly lower in the Post-implementation group.

The in-hospital mortality rate is significantly improved in the Post-implementation group compared to the Pre-implementation group, with average mortality rates of 29% and 45% (p= 0.029).

*Table 2 Baseline characteristics compare between Pre-implementation and Post-implementation periods.*

| | **All patient (n=319)** | **Pre-implementation (n=164)** | **Post-implementation (n=155)** | **p-value** |
|---|---|---|---|---|
| **Age, year, mean (SD)** | 66 (17.3) | 68 (17) | 65 (18.2) | 0.9080 |
| **Sex, male, n (%)** | 164 (51) | 81 (0.5) | 83 (0.5) | 0.9250 |
| **Vital signs, mean (SD)** | | | | |
| Heart rate, beats per minute | 117 (21.8) | 115 (20) | 118 (24.8) | 0.9037 |
| Temperature, Celsius | 38.8 (1.5) | 38.8 (1.6) | 38.8 (1.5) | 0.9468 |
| Respiratory rate, breath/min | 24 (6.8) | 25 (6.7) | 24 (6.9) | 0.8848 |
| Systolic blood pressure, mmHg | 125 (37.7) | 127 (38.8) | 118 (35) | 0.7971 |
| Diastolic blood pressure, mmHg | 74 (2) | 72 (35.5) | 70 (32.2) | 0.9505 |
| Oxygen saturation, % (SD) | 96 (5.2) | 97 (4.8) | 96 (5.2) | 0.9223 |
| GCS, Median (IQR) | 14 (9-15) | 14 (9-15) | 14 (9-15) | 0.9540 |
| **Chief complaint, n (%)** | | | | |
| Fever | 116 (36.4) | 54 (32.9) | 62 (40.0) | 0.1893 |
| Alteration of consciousness | 55 (17.2) | 30 (18.3) | 25 (16.1) | 0.6090 |
| Dyspnea | 87 (27.3) | 47 (28.7) | 40 (25.8) | 0.5670 |
| Malaise | 11 (3.4) | 6 (3.7) | 5 (3.2) | 0.7450 |
| Unresponsive | 7 (2.2) | 4 (2.4) | 3 (1.9) | 0.8560 |
| Other | 43 (13.5) | 23 (14.0) | 20 (12.9) | 0.7690 |
| **Venous lactate, mmol/L, mean (SD)** | 2.88 (1.58) | 3.1 (1.7) | 2.5 (1.55) | 0.7241 |
| **Shock, n (%)** | 103 (32.3) | 52 (31.7) | 51 (32.9) | 0.9546 |
| **Disposition, n (%)** | | | | |
| General ward | 270 (84.6) | 141 (86) | 129 (83.2) | 0.6254 |
| Intensive ward | 47 (14.7) | 22 (13.4) | 25 (16.1) | 0.8421 |
| Dead at the Emergency Department | 2 (0.6) | 1 (0.6) | 1 (0.6) | 1.0000 |
| SOS score, Median (IQR) | 6 (4-7) | 6 (4-7) | 6 (4-7) | 0.8825 |
| **Source of infection, n (%)** | | | | |
| Pulmonary | 138 (43.3) | 70 (42.7) | 68 (43.9) | 0.8305 |
| Urinary tract | 39 (12.2) | 20 (12.2) | 19 (12.3) | 0.9863 |
| Gastrointestinal | 34 (10.7) | 15 (9.1) | 19 (12.3) | 0.8102 |
| Skin | 18 (5.6) | 10 (6.1) | 8 (5.2) | 0.7172 |
| CRBSI | 8 (2.5) | 5 (3) | 3 (1.9) | 0.5251 |
| Ear, Nose, Throat | 3 (0.9) | 2 (1.2) | 1 (0.6) | 0.5953 |
| Gynecology | 1 (0.3) | 1 (0.6) | 0 (0) | 0.3302 |
| CNS infection | 1 (0.3) | 1 (0.6) | 0 (0) | 0.3300 |
| Unknown | 77 (24.1) | 40 (24.4) | 37 (23.9) | 0.9137 |
| **Time to antibiotic, minutes (SD)** | 43 (30.2) | 54 (35.6) | 34 (19.5) | 0.0315 |
| **Time to antibiotic ≤ 60 minutes, n (%)** | 214 (67.0) | 83 (50.6) | 131 (84.5) | <0.001 |
| **Non-survival, n (%)** | 119 (37.3) | 74 (45.1) | 45 (29.0) | 0.0029 |

*SD, standard deviation; IQR, interquartile range; CRBSI, catheter-related bloodstream infection; CNS, Central nervous system; SOS, Search Out Severity;*

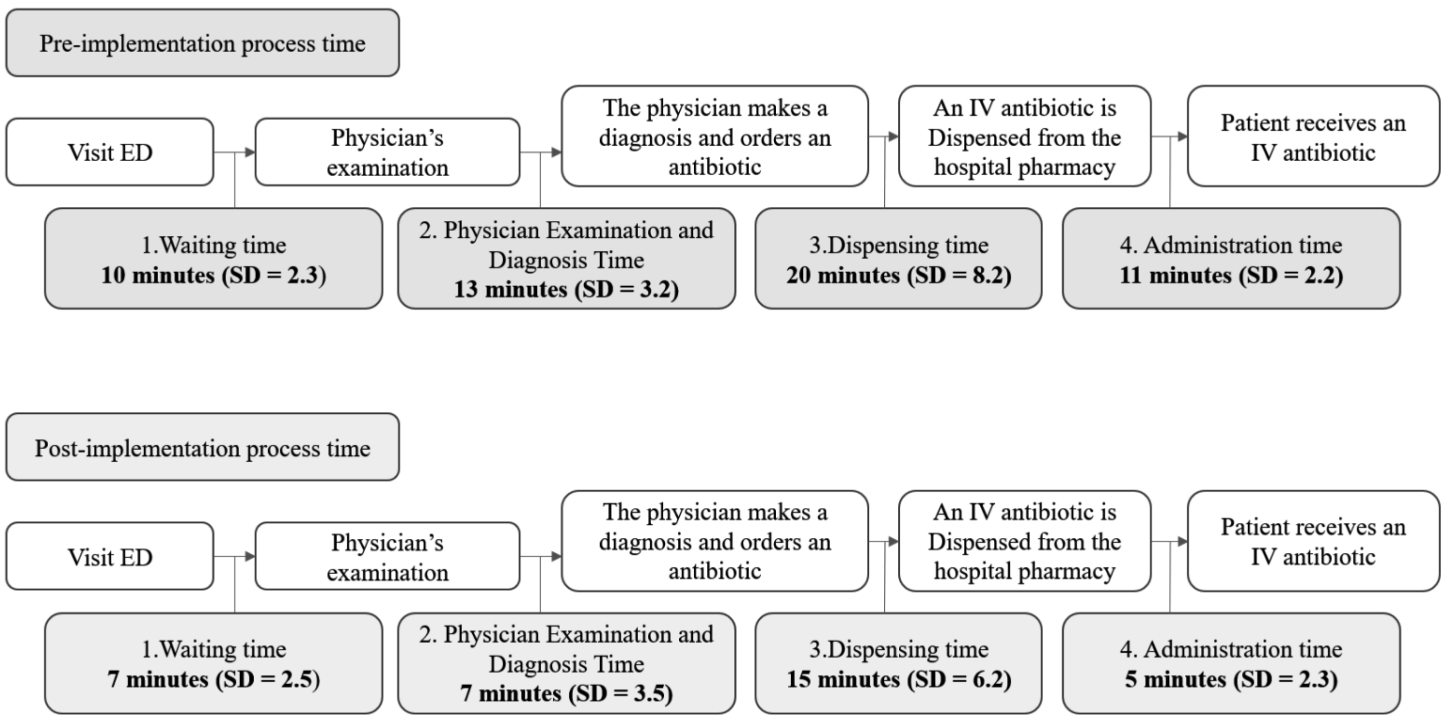



Figure 4 The duration of each process leads to administering the IV antibiotic to the patient, comparing the pre and post-implementation period. IV, Intravenous.

## DISCUSSION

Our findings demonstrate that the Fast track Alert System Timer (FAST) can decrease the Time to antibiotic by 20 minutes. Moreover, the mortality rate of septic patients is significantly improved by 16% compared to the pre and post-implementation period. This finding is similar to the study conducted by Marto JP et al.[14] in 2019. The study explores the effects of Highly Visible Wall-Timer to reduce Endovascular Treatment Time for Stroke, resulting in faster angio-suite-to-groin time (28 versus 33 minutes; p=0.02). This study applies the same strategy, which utilizes the countdown timer system to expedite the care process in the same manner the previously mentioned study was performed.

Analyzing processes leading to an antibiotic administration found that the duration in which each process is performed is significantly lower in the Post-implementation group. However, the exact reason for the time reduction is not included in this study or the previous study.

In 2019, to improve IV thrombolysis and endovascular therapy in Acute Ischemic Stroke (AIS) patients, the study performed by Matsumoto S et al.[15], which implemented a novel application for smart devices named "Task Calc. Stroke" (TCS), can visualize the real-time progress of crucial tasks for AIS on a dashboard by changing color indicators found that The door-to-CBC time was significantly reduced in the TCS-based Code Stroke group compared to the phone-based Code Stroke group, from 31 to 19 minutes (p = 0.043) The rate of IV thrombosis was higher in the TCS-based CS group (78% vs. 46%, p = 0.037). They concluded that using TCS can reduce the burden of information sharing within the AIS care team. In line with the previous study, this study employs a step-by-step protocol that exhibits, on the 55-inch display, the current process being performed and the time left, which can also reduce the burden of communication among the team members and facilitate the care process.

Real-time feedback of the time left in each process to the team members is essential to improve the quality of the care process[16]. As a result of the complicated nature of the feedback process, many institutions try to avoid it[17]. The Fast track Alert System Timer (FAST) can support team members with complex tasks of time recording, calculating the time left in each process, and Alerting other staff members.

Moreover, rapid-cycle/PDSA feedback is essential in improving sepsis care quality, which can be explained by a multi-disciplinary team-based approach and improved communication between medical specialists and other allied healthcare providers as shown in the study performed by Seoane L[18]. FAST provides rapid feedback to the healthcare provider which can alleviate the burden of communication between the team members and get everyone on the same page about what the current task is being done and how much time is left to create the sense of urgency when the countdown is running out of time.

An additional function of FAST is "Days without a delayed antibiotic", which imitates the "Days without an incident" from a safety scoreboard on an industrial work site. This function displays the number of days in which the last antibiotic delay occurred. This function encourages the healthcare provider to beat their previous best record. It's believed that visually communicating an incident-free day cultivates safety in the workplace and many industries apply this strategy to improve safety outcomes in their practice now, including medicine.

**Table 3** The comparison in mortality rate between Delayed ATB group (>60 minutes) and non-Delayed ATB group (<60 minutes)

| | Total cases | Dead | Survive | p-value |
|---|---|---|---|---|
| Time to ATB < 60 minutes, n (%) | 214 | 70 (32.7) | 144 (67.2) | 0.0154 |
| Time to ATB > 60 minutes, n (%) | 105 | 49 (46.6) | 56 (53.3) | |
| **Total, n** | **319** | **119** | **200** | |

The reduction in mortality rate in the post-implementation period coincides with the reduction in Time to antibiotic. Our result is comparable with the study performed by Yunjoo Im5 in 2022. Their study, which was conducted in 3,055 septic patients, found that, for patients with septic shock, the administration of broad-spectrum antibiotics within one hour of sepsis recognition can reduce in-hospital mortality rate OR 0.66 (95% CI 0.44–0.99; p = 0.049). However, the adjusted OR for in-hospital mortality in patients with sepsis without shock with time-to-antibiotics within one hour was 0.85 (95% CI 0.64–1.15; p = 0.300). This outcome is similar to many previous studies[19],[20],[21]. Our study found that the mortality rate for all septic patients, whether with or without shock, is lower in all septic patients who received the antibiotic within 1 hour, which may result from a smaller study population.

Our study has several limitations. First, our study population is smaller than the previous study. Second, the study was conducted in a single center, thus limiting generalizability, mainly because of the differences in sepsis protocol across the different institutions. Finally, the study does not include the intubation or vasopressor status, which may benefit from early antibiotic administration.

## CONCLUSION

Fast track Alert System Timer can improve the Time to antibiotic in septic patients. This study outlines an easy-to-implement, low-cost solution for emergency departments looking to shorten Time to antibiotic.

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