

Knowledge for Assessments and Management in the Early Stage of Sepsis in Critical Care Pediatric Patients among Pediatric Nurses at the Tertiary Care Level Hospital, Northeastern of Thailand

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Abstract— Pediatric sepsis is usually measured to comprise a range of disorders that result from infection by bacteria, viruses, fungi, or parasites. Literature was prolific around effects of sepsis, septic shock, sepsis assessment and management but none had woven these topics together to explore what was going on in the role of pediatric nursing. The descriptive study aimed to study the knowledge for assessments and management of the early stage of sepsis among pediatric nurses. The descriptive results were employed in the full research process for development of Clinical Nursing Practice Guideline Development. The purposive sample consisted of 30 nurses who worked in pediatric intensive care unit at the tertiary care level hospital, Northeastern of Thailand. The knowledge for assessments and management tool has developed by the researchers and verified by five experts. The questionnaire content validity indexes were 0.9. Reliability was tested using KR-20 was 0.77. Data were analyzed by descriptive statistics. The findings of the study showed the aged group between 20-30 years 67%, 31-40 years 23% and 41-50 years 10%. The working experiences in a pediatric intensive care unit less than 5 years 37%, 5-10 years 50%, 10-15 years 0% and over 15 years 13%. There are experienced in training about pediatric sepsis 77% and there have not being trained 23%. The pediatric nurses had a knowledge level for assessments and management of pediatric patient in the early stage of sepsis in a most medium level as 63.4% and low level as 36.6 %, none of them is in high level. This study suggests that education pediatric nurses about the knowledge for assessments and management in the early stage of sepsis in pediatric patients should be provided and the clinical nursing practice guideline for pediatric care and prevention progressive of sepsis in pediatric patient should be developed.

Keywords— Critical care pediatric Nurse, Sepsis assessment and management.

I. INTRODUCTION

Sepsis is a clinical syndrome resulting from a dysregulated systemic inflammatory response to infection. It is the complex interaction between infection pathogen, the host immune response, inflammatory process coagulation process and possibly genetic factors may result different in the severity of the disease in each patient [1]. The normal host response to infection is an inflammatory process aimed at localizing and controlling the infection is balanced by anti-inflammatory cytokines. Sepsis occurs when this normal pro-inflammatory host response exceeds its usual homeostatic imbalance and

becomes a systemic process which may leads to multiple organs failure and death [2, 3]. Sepsis is remains a burdensome public health problem and the most common cause of morbidity and mortality in infant and children worldwide [4]. Sepsis is a life-threatening condition commonly treated in pediatric intensive care unit (PICU). It is estimated that over one-third of children who die in tertiary care PICU within the United States have severe sepsis [5]. The largest epidemiological reports of the incidence of severe sepsis in children come from three cohort studies. One cohort dataset from seven U.S. states. These studies show rising annual incidence of children were hospitalized with severe sepsis over this time period (0.56 to 0.89 cases per 1,000 children, across all age groups) and the prevalence of severe sepsis in newborns more than doubled, from 4.5 to 9.7 cases per 1,000 births. Despite the rising incidence of severe sepsis, but the case fatality rate has fallen from 10.3% to 8.9% [6]. A large international point prevalence study of severe sepsis in 128 PICUs from 26 countries found the prevalence of severe sepsis in pediatric intensive care units was 8.2% (95% confidence interval, 7.6-8.9%). The patients' median age was 3.0 (interquartile range [IQR], 0.7-11.0) years. The most frequent sites of infection were respiratory (40%) and bloodstream (19%) [5]. And the largest report from the Pediatric Health Information System database collected by the Children's Hospital Association from 2004 to 2012 finding pediatric severe sepsis prevalence was 7.7% (49,153) with an associated mortality rate of 14.4% in infant (odds ratio, 1.4), underlying cardiovascular condition (odds ratio, 1.4) and multiple organ dysfunction, conferred higher odds of mortality. Resource burden was significant with median hospital length of stay of 17 days (IQR, 8-36 days) and PICU length of stay of 7 days (IQR, 2-17 days), with median cost/day of \$4,516 and median total hospitalization cost of \$77,446. There was a significant increase in the severe sepsis prevalence rate from 6.2% to 7.7% from 2004 to 2012 ($p < 0.001$) and a significant decrease in mortality from 18.9% to 12.0% ($p < 0.001$). Individual center's prevalence and volume are positively correlated with cost [6].

Over two decades, sepsis has been defined as systemic inflammatory response syndrome (SIRS) was introduced as

the first step of the activation of inflammatory cascade cause by infection both for adults and children. After that the European Society of Intensive Care Medicine and the Society of Critical Care Medicine reexamine new sepsis criteria were advocated as “Sepsis-3” in 2017 because limitations of previous definitions included an excessive focus on inflammation, the misleading model that sepsis follows a continuum through severe sepsis to shock, and inadequate specificity and sensitivity of SIRS criteria to screen at-risk patients and that the severity of organ dysfunctions [7]. According to new sepsis definition sepsis as infection complicated by one or more organ dysfunctions. Unfortunately this change in the definition of sepsis is only applied to adult population at this moment [8]. Although, the definition of pediatric sepsis according to the definitions published in 2005 from the International Consensus Conference on Pediatric Sepsis. SIRS is occurring together early stage in sepsis is defined by the presence of at least two of the following four criteria: 1) core temperature of $>38.5^{\circ}\text{C}$ or $<36^{\circ}\text{C}$, 2) tachycardia in the absence of pain stimuli or drugs, or bradycardia for children <1 year old in the absence of external vagal stimulus, drugs or congenital heart disease, 3) tachypnea or mechanical ventilation for an acute process, and 4) elevated or depressed leukocyte count, or greater than 10% immature neutrophils. One of which must be abnormal temperature or leukocyte count. If SIRS associated with a suspected or proven infection of any origin this is defined as sepsis. As sepsis plus organ dysfunction becomes widespread, the patient is declared as having severe sepsis, and once cardiovascular dysfunction present, this is defined as septic shock, the final stage of the sepsis continuum [9]. Each process play a role in the progression of sepsis and influence the development of multiple organ failure. The growing number of patient with severe sepsis and septic shock, the American Collage of Critical Care Medicine (ACCM) published clinical practice parameters for hemodynamic support of pediatric and neonatal shock in 2002 and updated these in 2017 in the ACCM clinical practice parameters for hemodynamic support of pediatric and neonatal septic shock [10]. The ACCM has resulted in a marked decrease in hospital length of stay and mortality both adult and pediatric patient. A care bundle is a set of protocols distilled from evidence based practice guidelines, bundle of care within an hour following early recognition of severe sepsis, vascular access, antibiotic administration, administering intravenous fluids, and vasopressors for fluid refractory shock. One study in the tertiary accident and emergency department at Boston Children’s Hospital, those who received the care bundle recommended by the ACCM guidelines had a significantly shorter intensive care length of stay (mean 5.5 vs 6.8 days) and hospital length of stay [11]. A study in the PICU of University referral hospital, Bangkok, Thailand reported a modified the Surviving Sepsis Campaign (SSC) from AACM for severe sepsis and septic shock significantly reduced the mortality rate from 42 to 19% [12]. Management of sepsis in pediatric first requires early recognition that can help to ensure prompt treatment to improve patient outcomes and can be life-saving for pediatric in developed and pre-developed countries.

[13-14]. Pediatric death reviews suggest failure to recognize severe sepsis and septic shock with delayed or inappropriate treatment at first contact with healthcare services [10].

Critical care pediatric nurses are the health care professional who care for patients at the bedside spends the greatest amount of time to play a role in the prevention, early recognition, diagnosis and starting treatment of sepsis to provide the best possible patient outcome [15]. So they must be knowledgeable in recognizing SIRS, sepsis and recommendations in the new SSC guidelines while also being aware of the importance of prompt intervention for management in the early stage of sepsis. However, previous studies addressed health care providers’ knowledge in recognizing sepsis come from different setting. One study was to assess the knowledge of acute and critical care pediatric nurses of SIRS diagnostic criteria, sepsis guidelines, and the importance of SIRS recognition, findings a significant knowledge deficit among participants in several key areas of SIRS/sepsis recognition. Item analyses demonstrated nurse’s difficulty recognizing patients in earlier stages of the sepsis continuum and significant confusion the role of blood pressure and serum lactate levels in diagnosing sepsis [16]. However, sepsis guidelines in this studies was SSC 2009, the current SSC guidelines updated in 2012- 2017 already.

Additionally, one study was to assess the knowledge for detection and management of adult patients in the early stage of septic shock among registered nurses who worked in medical and surgical wards at a university affiliated hospital. The findings of the study showed that most of the registered nurses had a low level of knowledge for detection, and a moderate level of the knowledge for management of patients in the early stage of septic shock [17]. And the recent study was to assess nurse’s knowledge, current practice of SIRS diagnostic criteria, sepsis guidelines and the importance of SIRS recognition among pediatric nurse at neonatal intensive care unit, the result of this study revealed that there were knowledge deficit between nurses’ about SIRS and sepsis [18].

Therefore, the purpose of this study was to assess the knowledge of sepsis continuum diagnostic criteria for assessments and management in the early stage of sepsis in pediatric patient among critical care pediatric nurses.

II. METHODS

Study Design

The descriptive research intended to assess critical care pediatric nurse’s knowledge of sepsis continuum diagnostic criteria for assessments and management in the early stage of sepsis in pediatric patient.

Setting and Samples

The purposive sample consisted of 30 nurses who worked in pediatric intensive care unit at the tertiary level hospital, Northeastern of Thailand. The following were the inclusion criteria: nurse who recurrently done at the bedside, have at least 1 year of working experience in PICU and are willing to participant in the study and provide written informed consent. Nurse who did not primarily work at the bedside, such as

nurse managers were excluded. The period of study from April to December 2016.

Ethical Considerations

The study was approved by the Khon Kaen University Ethics Committee of Human Research based on the Declaration of Helsinki and the ICH Good Clinical Practice Guidelines, in Thailand, approval number 4.2.01: 47/2016. The participants informed about the privacy of their information. The study was respect of person, beneficence or non-maleficence and justice. The participants were informed of the aim, the procedure of the research and ask questions that do not understand before providing written consent. The participants were informed that they could withdraw from the study at any time without any reason given.

Instrument

One instrument was used to collect the data was the knowledge about sepsis continuum diagnostic criteria for assessments and management in the early stage of sepsis in pediatric patient questionnaire. The questionnaire has developed by the researchers and then verified by five experts including: the physician lecturer from Department of Pediatrics Critical Care Medicine, Khon Kaen University, two lecturer of Pediatric Nursing from Faculty of Nursing, Khon Kaen University and Mahasarakham University, Thailand, and two nurses certified in pediatric critical care nursing from PICU Srinagarind Hospital, Thailand. This provided content validity. The questionnaires comprise four part as the following:

Part one: demographic information in the instrument included age group, highest educational degree, experiences in training of Certificate in Nursing Specialty in Pediatric Critical Care Nursing, the working experiences in PICU and experienced in training about pediatric sepsis

Part two: the questionnaire about sepsis continuum diagnostic criteria for assessments in the early stage of sepsis in pediatric patient included standard sepsis definition, pathology of infection and signs and symptom of sepsis.

Part three: the questionnaire to test pediatric nurse's knowledge for management in the early stage of sepsis in pediatric patient according to SSC guideline 2012-2017, included initial assessment and diagnosis early stage of sepsis, maintenance and reduce oxygen consumption, vascular access for fluid resuscitation, antibiotics and source control, administration of inotropes vasopressor and vasodilators drugs, clinical monitoring to evaluation patients' response to treatment and therapeutic end points and blood samples and monitoring of laboratory results.

Part four: includes case studies sorted by correctly identified answer.

The questionnaire consists a total of 50 items, score is between 0-50 points. The scoring system for knowledge of studied nurses was calculated as the following: 1= correct answer, 0 = incorrect answer and their level of knowledge were translated into percentages based on the principle of scoring categorized is divided into three levels, the overall interpretation is as the following [19]:

If the mean of the percentages ranged from 0 - 59.99 (0 - 29.99 points), predictable the pediatric nurses had a knowledge level for assessments and management of pediatric patient in the early stage of sepsis in a low level.

If the mean of the percentages ranged from 60 - 79.99 (30 - 39.99 points), predictable the pediatric nurses had a knowledge level for assessments and management of pediatric patient in the early stage of sepsis in a medium level.

If the mean of the percentages ranged from 80 - 100 (40 - 50 points) predictable the pediatric nurses had a knowledge level for assessments and management of pediatric patient in the early stage of sepsis in a high level.

A pilot studies of a heterogeneous group consisted of 15 nurses who worked in pediatric intensive care unit at a regional, Khon Kaen hospital, Thailand, which is similar context of health service level at the research area. Results were analysis of content validity and reliability by the researcher and then submitted to a statistical consultation service at a local university found that, the questionnaire content validity was tested using content validity indexes (CVI) were 0.9 and reliability was tested using Kuder Richardson (KR-20) was 0.77 respectively.

Data Collection and Procedures

After obtaining Institutional Review Board approval and submitting an official letter from the dean of the Faculty of Nursing Khon Kaen University to director of the tertiary level hospital, the participants were receive oral and written information regarding the purpose, procedure participants' rights and potential benefits and risks of the study and then were asked or their information consent. The researchers given questionnaire to the participants and tell them to send directly to the researcher. The researchers collected the data during the morning and afternoon shift every day from 9 AM to 10 PM. until all the participants done the questionnaire was finished. The data were collected from April to December 2016.

Data Analysis

The data were analyzed by descriptive statistics such as average and percentage.

III. RESULTS

Demographic Information

Among 30 nurses in the organization who were eligible to participate and completed the questionnaire. The data were analyzed using a sample of 30 person result shown as 67% of pediatric nurse have the aged group between 20 - 30 years, and mean age 29.5 ± 5.94 years respectively. The majority 96% graduate Bachelor degree of Nursing. 50% of them had the working experiences in PICU between 6 - 10 years, mean 7.5 ± 4.71 years and median 6.57 years respectively. Thirty percent have experiences in training of Certificate in Nursing Specialty in Pediatric Critical Care Nursing. Seventy-seven percent of them had experienced in training about pediatric sepsis (Table 1).

Analysis of the Questionnaire

The questionnaire consists a total of 50 items. Part 2 of the questionnaire consists of 17 items was to assess pediatric

nurse’s knowledge of the standard sepsis definition (1-8 items), pathology of infection (9-14 items) and signs and symptom of sepsis (15-17 items), in which respondents had to decide if the statements were true or false (Table 2).

TABLE 1. Demographic information (N=30)

Demographics	Total (N=30) N (%)
1. The age group (years) - 20 - 30 - 31 - 40 - 41 - 50	29.5 ± 5.94 ^a , rang 24-50 years 20 (66.7) 7 (23.3) 3 (10)
2. Highest educational degree of Nursing - Bachelor degree - Master degree	29 (96.7) 1 (3.3)
3. The working experiences in PICU (years) - 1 - 5 - 6 - 10 - > 15	11 (36.7) 15 (50) 4 (13.3)
4. Experiences in training of Certificate in Nursing Specialty in Pediatric Critical Care Nursing - Yes - No	9 (30) 21 (70)
5. Experienced in training about pediatric sepsis - Yes - No	7.5 ± 4.71 ^b , median 6.57 years 23 (76.7) 7 (23.3)

Note: ^{a,b} = Mean ± Standard deviation.

TABLE 2. List of Part 2 of the standard sepsis definition, pathology of infection and signs and symptom of sepsis. Which of the following were true or false about sepsis

Statement	Correct Answer	Number of responses, n (%)	
		Yes	No
The standard sepsis definition			
1. Systemic inflammatory response syndrome (SIRS) is a generalized inflammatory and the inflammatory process can be caused by the immune response to infection or severe trauma.	Yes	23 (76.6)	7 (23.4)
2. Important indications for the diagnosis of SIRS include the presence of at least two of four criteria, one of which must be abnormal temperature and/ or abnormal platelet count.	No	15 (50)	15 (50)
3. Pediatric patient who has abnormal temperature and tachypnea indicate that the patient has SIRS that may be cause by infection.	Yes	21 (70)	9 (30)
4. Infection is a suspected or proven infection with any pathogen that early diagnosis can be based on the clinical presentation and symptoms.	Yes	26 (86.7)	4 (13.3)
5. Sepsis is defined as a suspected or known infection of any origin is present with SIRS.	Yes	25 (83.4)	5 (16.6)
6. Severe sepsis is defined as sepsis with accompanying organ dysfunction	Yes	25 (83.4)	5 (16.6)
7. If the pediatric patient has septic shock may be have clinical sign and symptoms of tissue hypo perfusion, such as altered level of consciousness, prolonged capillary refill time >2 seconds, diminished pulses, cold extremities and mottling etc.	Yes	23 (76.7)	7 (23.3)
8. Cardiovascular dysfunction is defined as patients have low blood pressure (BP), increase lactate levels and need for inotropic drugs to maintain BP in normal range.	Yes	27 (90)	3 (10)
Pathology of infection			
9. Sepsis is a clinical syndrome resulting from a dysregulated systemic inflammatory response to infection that affects the immune system, inflammatory process and blood clotting system.	Yes	29 (96.7)	1 (3.3)
10. Immune suppression that occurs in the late stage of sepsis which lead to widespread tissue injury and organ dysfunction.	No	4 (13.3)	26 (86.7)
11. When there is infection in the body, immune cells (such as macrophages) can stimulate the production of pro-inflammatory cytokines such as C-reactive protein (CRP) and Procalcitonin (PCT).	No	0 (0)	30 (100)
12. The elevation of serum lactate level in the state of septic shock as a result of, when oxygen delivery fails, energy production switches to anaerobic and this results in the production of pyruvate that is converted to lactate.	Yes	27 (90)	3 (10)
13. Immunoparalysis is usually seen in the early stages of sepsis.	No	22 (73.3)	8 (26.7)
14. Septic shock is a type of shock that is caused by obstructive shock.	No	19 (63.3)	11 (36.7)
Signs and symptom of sepsis			
15. In pediatric patients with warm shock can recognized when pediatric who have diminished pulses, prolonged capillary refill time and oliguria, etc.	No	11 (36.7)	19 (63.3)
16. When a pediatric has an early stage of septic shock, they often have early clinical sign such as hypotension and oliguria.	No	16 (53.3)	14 (46.7)
17. In early severe sepsis, pediatric patient often have a metabolic acidosis from central mediated hyperventilation.	No	2 (6.7)	28 (93.3)

Part 3 of the questionnaire consists of 30 items to test pediatric nurse’s knowledge for management in the early stage of sepsis in pediatric patient according to SSC guideline 2012-2017, included initial assessment and diagnosis early stage of sepsis was scenarios to indicate child was experiencing sepsis or not (18-20 items), maintenance and reduce oxygen consumption (21-24 items), vascular access for fluid

resuscitation (25-29 items), antibiotics and source control (30-34 items), administration of inotropes vasopressor and vasodilators drugs (35-38 items), clinical monitoring to evaluation patients’ response to treatment and therapeutic end points (39-43 items), and blood samples and monitoring of laboratory results (44-47 items).

TABLE 3. List of Part 3 of the pediatric nurse's knowledge for management in the early stage of sepsis in pediatric patient according to SSC guideline 2012-2017. Which of the following were true or false about sepsis

Statement	Correct Answer	Number of responses, n (%)	
		Yes	No
Initial assessment and diagnosis early stage of sepsis			
18. Eight-year-old, severe cough, increase work of breathing. BT 38.7 °C, HR 160/min, RR 35/min, BP112/68 mmHg, O ₂ sat 95%, On room air, Cap refill 2-3 seconds and WBC 10.8 x 10 ³ /mm. This scenarios to indicate child was experiencing sepsis or not?	Yes	24 (80)	6 (20)
19. Eleven-month-old infant who presents to the emergency department with appears very agitated but able to control, BT 36.2 °C, HR 150/min, RR 38/min, BP 80/40 mmHg, O ₂ sat 96%, On room air, Cap refill 3 seconds and WBC 6 x 10 ³ /mm. This scenarios to indicate child was experiencing sepsis or not?	No	20 (66.7)	10 (33.3)
20. Three-year-old who is being transferred to emergency department to rule out appendicitis. BT 39 °C, HR 180/min, RR 42/min, BP 90/40 mmHg, WBC 6 x 10 ³ /mm, O ₂ sat 90%, On room air, Cap refill 5 second and agitation. This scenarios to indicate child was experiencing sepsis or not?	Yes	26 (86.7)	4 (13.3)
Maintenance and reduce oxygen consumption			
21. The first fundamental principle of nursing care for pediatric patients with severe sepsis is remain airway and breathing.	Yes	18 (60)	12 (40)
22. Early starting with oxygen administered to pediatric patients who present severe sepsis can reduce functional residual capacity (FRC) and increase work of breathing.	No	8 (26.7)	22 (73.3)
23. Should not be use sedative drug for sedation pediatric patient during septic shock before invasive procedure such as intubation, access central line, etc. Because it can cause of hypotension.	No	21 (70)	9 (30)
24. When nursing assessment found pediatric patient present with increase work of breathing, hypoventilation and altered mental status. Nurse should be prompt notify physician for considered early intubation.	Yes	29 (96.7)	1 (3.3)
Vascular access for fluid resuscitation			
25. When pediatric patient who has severe sepsis or septic shock. Nurse should rapid attainment of at least 2 large peripheral vascular access for fluid resuscitation and inotropic drugs administered.	Yes	26 (86.7)	4 (13.3)
26. Crystalloids solution administered such as 0.9% normal saline potential benefits, has a large molecule, cannot leakage from blood vessels and improve hemodynamic function.	No	8 (26.7)	22 (73.3)
27. When pediatric patient has septic shock receive a large fluid resuscitation and fluid overload occur. However, patients were still shock, can determined for fluid administered until clinical shock improves.	No	27 (90)	3 (10)
28. Pediatric patients with septic shock (warm shock) should consider rapid fluid resuscitation, as the patient has vasoconstriction and massive vascular leakage to extravascular compartment.	No	13 (43.3)	17 (56.7)
29. Normal blood pressure in pediatric patients after received large amounts of fluid resuscitation is the best clinical parameter for evaluate patient response to fluid treatment.	No	8 (26.7)	22 (73.3)
Antibiotics and source control			
30. Antibiotic administered and early aggressive infection source control in pediatric patient who has severe sepsis or septic shock is considered a supportive treatment.	No	17 (56.7)	13 (43.3)
31. The empiric antibiotic should be administered within 1 hr. of the identification of pediatric patient severe sepsis or septic shock.	Yes	26 (86.7)	4 (13.3)
32. Blood cultures should be obtained before administering antibiotic.	Yes	29 (96.7)	1 (3.3)
33. When cannot attainment peripheral vascular access for given antibiotics. You can be given via intramuscularly or orally until intravascular line access is available.	Yes	16 (53.3)	14 (46.7)
34. When pediatric patients with septic shock and phlebitis occur after receive inotropic drugs. Nurses should stop the drug and access new vascular immediately.	Yes	30 (100)	0 (0)
Administration of inotropes vasopressor and vasodilators drugs			
35. In theory, Dopamine is the best choice of inotrope drug for treatment of septic shock patient. Because, the action of that can resist pathophysiology of septic shock.	No	11 (36.7)	19 (63.3)
36. When pediatric patients with septic shock who are not responsive to fluid resuscitation, should be use Dopamine as first-line inotrope support.	Yes	22 (73.3)	8 (26.7)
37. Pediatric patients with septic shock (cold shock). Normal BP, cold extremities and prolonged capillary refill can be required for Dobutamine and Norepinephrine drugs administered.	No	10 (33.3)	20 (66.7)
38. In pediatric patients who received Milrinone. Nurse should be monitor side effect from that such as hypotension and cardiac arrhythmia etc.	Yes	29 (26.9)	1 (3.3)
Clinical monitoring to evaluation patients' response to treatment and therapeutic end points			
39. Nurses should be closely monitored changes of mental status in pediatric patients who has sepsis.	Yes	30 (200)	0 (0)
40. Nurses should be monitored urine output to achieve the target gold is urine output ≥ 0.5 ml / kg / hr. in pediatric patients who has septic shock.	No	6 (20)	24 (80)
41. In pediatric patient who require mechanical ventilation should be maintain a central venous pressure (CVP) between 8-12 mmHg.	No	2 (6.7)	28 (93.3)
42. The therapeutic end point gold in pediatric severe sepsis include maintain central venous oxygen saturation (ScvO ₂) ≥ 95%.	No	17 (56.7)	13 (43.3)
43. The therapeutic end point gold in pediatric septic shock include maintain cardiac index between 3.3 – 6 L/min/meter.	Yes	26 (86.7)	4 (13.3)
Blood samples and monitoring of laboratory results			
44. When pediatric patient with viral infection it has been recognized Procalcitonin (PCT) levels are increased immediate.	No	10 (33.3)	20 (66.7)
45. In pediatric patients with septic shock should be monitored blood glucose target ≤ 200 mg/dL.	No	3 (10)	27 (90)
46. In pediatric patients with septic shock present with elevate serum lactate level. It's an indicator decrease in blood flow through microcirculation and tissue hypoxia.	Yes	29 (96.7)	1 (3.3)
47. In pediatric patients with severe sepsis and septic shock who still has hemodynamic unstable should be maintained hemoglobin ≥ 7 mg/dL.	No	5 (16.7)	25 (83.3)

The questionnaire comprised a total of 50 items. The mean number of total correct responses was 30.3 (60.6%) (SD=4.54), with a range of 21-38 (43% -76%), can refer to the most of pediatric nurses had knowledge for assessments and management in the early stage of sepsis in pediatric patients in medium level. When classifying knowledge level of nurses into 3 levels was found that, nurses 12 person (40%) had low level of knowledge, 18 person (60%) had medium level of knowledge and, none of them is in high level (Table 6).

TABLE 4. The data showed the mean score, standard deviation, and knowledge level of pediatric nurse about sepsis continuum diagnostic criteria for assessments in the early stage of sepsis in pediatric patient.

Knowledge	Possible score	Real score	Mean score (%)	SD	Knowledge level
Overall second part of the questionnaire	0-17	7-14	10.5 (61.76%)	1.83	medium
Standard sepsis definition	0-8	3-8	6.17 (71.12%)	1.31	medium
Pathology of infection	0-6	1-5	3.37 (56.1%)	0.85	low
Signs and symptom of sepsis	0-3	0-3	0.97 (32%)	0.89	low

Note. SD= Standard deviation.

The second part of the questionnaire, pediatric nurse's knowledge about sepsis continuum diagnostic criteria for assessments in the early stage of sepsis in pediatric patient (Table 2). The mean number of correct responses was 10.5 (61.76%) (SD=1.83), can refer to the pediatric nurses had knowledge about sepsis continuum diagnostic criteria for assessments in the early stage of sepsis in pediatric patient in medium level. When classifying knowledge scores into subpart was found that, the mean number of correct responses about standard sepsis definition was 6.17 (71.12%) (SD=1.31), pathology of infection was 3.37 (56.1%) (SD=0.85) and signs and symptom of sepsis was 0.97 (32%) (SD=0.89), can refer to, the pediatric nurses had knowledge about standard sepsis definition in medium level while pathology of infection, signs and symptom of sepsis in low level. When classifying knowledge level of nurses into 3 levels was found that, nurses 15 people (50%) had low level of knowledge, 12 people (40%)

had medium level of knowledge and 3 people (10%) had high level of knowledge (Table 4).

The three part of the questionnaire to test pediatric nurse's knowledge for management in the early stage of sepsis in pediatric patient according to SSC guideline 2012-2017 (Table 3). The mean number of correct responses was 18.16 (60.53%) (SD=3.0), can refer to the pediatric nurses had knowledge for management in the early stage of sepsis in pediatric patient in medium level. When classifying knowledge scores into subpart was found that, the mean number of correct responses about initial assessment and diagnosis early stage of sepsis was 2.33 (77.66%) (SD=0.71), maintenance and reduce oxygen consumption was 2.53 (63.25%) (SD=0.81), vascular access for fluid resuscitation was 2.73 (54.6%) (SD=1.04), antibiotics and source control was 3.93 (78.6%) (SD=0.82), administration of inotropes vasopressor and vasodilators drugs was 2.4 (60%) (SD=0.81), clinical monitoring to evaluation patients' response to treatment and therapeutic end points was 2.7 (54%) (SD=0.79), and blood samples and monitoring of laboratory results was 1.53 (38.25%) (SD=0.73), can refer to the pediatric nurses had knowledge about initial assessment and diagnosis early stage of sepsis in medium level, maintenance and reduce oxygen consumption in medium level, vascular access for fluid resuscitation in low level, antibiotics and source control in medium level, administration of inotropes vasopressor and vasodilators drugs in medium level, clinical monitoring to evaluation patients' response to treatment and therapeutic end points was in low level, and blood samples and monitoring of laboratory results in low level. When classifying knowledge level of nurses into 3 levels was found that, nurses 13 people (43.4%) had low level of knowledge, 16 people (53.3%) had medium level of knowledge and only one person (3.3%) had high level of knowledge (Table 5).

The four part of the questionnaire consist of 2 cast study to test pediatric nurse's knowledge about how the patients should be initial managed (Table 4). The mean number of correct responses was 1.63 (54.3%) (SD=1.03), can refer to the pediatric nurses had knowledge about initial management of a pediatric patient experiencing sepsis in low level.

TABLE 5. The data showed the mean score, standard deviation, and knowledge level of pediatric nurse about management in the early stage of sepsis in pediatric patient according to SSC guideline 2012-2017

Knowledge	Possible score	Real score	Mean score (%)	SD	Knowledge level
A total 50 items of the questionnaire	0-50	21-38	30.3 (60.6%)	4.54	medium
Overall three part of the questionnaire	0-30	11-24	18.16 (60.53%)	3.0	medium
Initial assessment and diagnosis early stage of sepsis was	0-3	1-3	2.33 (77.66%)	0.71	medium
Maintenance and reduce oxygen consumption	0-4	1-4	2.53 (63.25%)	0.81	medium
Vascular access for fluid resuscitation	0-5	0-4	2.73 (54.6%)	1.04	low
Antibiotics and source control	0-5	2-5	3.93 (78.6%)	0.82	medium
Administration of inotropes vasopressor and vasodilators drugs	0-4	0-4	2.4 (60%)	0.81	medium
Clinical monitoring to evaluation patients' response to treatment and therapeutic end points	0-5	2-5	2.7 (54%)	0.79	low
Blood samples and monitoring of laboratory results	0-4	0-3	1.53 (38.25%)	0.73	low

IV. DISCUSSION

The result of present study regarding demographic characteristics of studied pediatric nurses revealed that the majority of nurses (67%) in PICU at the tertiary level hospital,

Northeastern of Thailand had the aged group between 20 - 30 years, half of them none had previous experienced in training about pediatric sepsis. This could be due to Critical Care Department had an orientation program about sepsis to teach all new nurses by the expert nurse, but content not specific for

pediatric patient. Guideline for management pediatric sepsis in this setting according to Surviving Sepsis Campaign (SSC), the training is provided by the expert physician, there are a few nurses who have attended because the schedule is not convenient. This could show that the most of nurses are newly educated and they need to acquire more knowledge and skill same the previous study that to evaluate knowledge and identification of sepsis among pediatric nurses at Neonatal Intensive Care Units in Egypt, the study showed that 71.1% of nurses were in the age group (20 - < 25) and none of nurses had any previous training related to sepsis or SIRS that may lead to unsafe care, this could be due to lack of motivation for training and work overload. In this regard enhancing nurse's level of education and continuous training through in-service education was promptly needed [20].

This study show that only (30%) of nurse had previous experiences in training of Certificate in Nursing Specialty in Pediatric Critical Care Nursing, which may be due to the unit nature, training this course depend on working experience in PICU that be similar to previous research that showed (36.8%) of nurse held a nursing certification, the most frequent being the Certified Pediatric Nurse [16]. The finding was incongruent with another study [17] who revealed none of nurse participant who held a nursing certification and the result of her study revealed that length of experiences training was not related to knowledge for assessments in the early stages of septic shock, but was positively related to knowledge for management of patients in the early stage of septic shock.

Only a few previous studies have described nurses' knowledge regarding the assessment and management of sepsis [20], especially in pediatric nurse found very few studies. The result of this study showed the majority of pediatric nurses (60%) had knowledge for assessments and management in the early stage of sepsis in pediatric patients in medium level and (40%) in low level. It is also important to note that none of them is in high level. This was similar to the result of many previous study that has found some ward nurses have a poor knowledge of the signs and symptoms of sepsis, severe sepsis and septic shock and some aspects of it is initial management [21]. This finding agreement with Jeffery who study to assess the knowledge of acute and critical care pediatric nurses of SIRS diagnostic criteria, sepsis guidelines, and the importance of SIRS recognition, found that a significant knowledge deficit among pediatric nurse in several key areas of SIRS/sepsis recognition, once item analyses demonstrated nurses easily recognize septic shock but have difficulty recognizing patients in earlier stages of the sepsis continuum. Significant confusion was evident regarding the role of blood pressure in septic shock that usually found in late stages of shock and a raised serum lactate levels indicate severe sepsis or that some signs of organ dysfunction occurred [16]. This finding agreement with Onuma who study the knowledge for detection and management of patients in the early stage of septic shock among registered ward nurses at university affiliated hospital, found that most of the nurses had a low level of knowledge for detection, and a moderate level of the knowledge for management of patients in the early stage of septic shock. This study suggested that educating all

registered nurses about the knowledge for detection, management of patients in the early stage of septic shock should be provided and the clinical practice guidelines for the early stage of septic shock patients should be developed [17].

In this study when divide in each part diagnostic criteria for assessments in the early stage of sepsis in pediatric patient showed pediatric nurses have low level of knowledge regard pathology of infection, and signs and symptom of sepsis. This was consistent with [17] who have found the same of result. Therefore, deficit of knowledge among pediatric nurse regarding signs and symptom of sepsis may be the result of not understand about pathophysiologic of infection, can cause nurses have difficult to early recognition of sepsis, such as hyper-immune or hyper-inflammation status that occurs in the early stage of sepsis causes auto-injury to the host, leading to multiple organ dysfunction syndrome, patient will have a clinical signs of inadequate tissue hypo-perfusion including any of the following: decrease or altered mental status, prolong capillary refill time, hypotension and, elevate serum lactate etc. [11] In part of knowledge for management in the early stage of sepsis in pediatric patient according to SSC guideline 2012-2017 found the majority of pediatric nurse have a knowledge in medium level. Although some topics were difficulty such as vascular access for fluid resuscitation, clinical monitoring to evaluation patients' response to treatment and therapeutic end points, finally blood samples and monitoring of laboratory results. Due to the success of the 2004 and 2012 surviving sepsis campaign guideline has resulted in a marked decrease in mortality rate of pediatric sepsis, the 2017 update complication and discussion of the new literature should be implemented in the update. The majority of nurse lack of knowledge about characteristic of fluid such as benefit or harm for select Isotonic Saline for resuscitation. This was consistent with [17] who found the nurses have a low level of knowledge for fluid resuscitation and homeostatic. This could be due to in reality; nurse cannot directly determine to select fluid for patient because the most of actions depend on the physician treatment order [17, 20]. The majority of nurses unable to identify the following for clinical monitoring to evaluation patients' response to treatment and therapeutic end points such as urine output greater than 1 ml/kg/hr., and central venous pressure (CVP) between 8 and 12 mm Hg for patient who not has mechanically ventilated, in mechanically ventilated patients a higher target CVP of 12-15 mm Hg. This may adequate for increasing oxygen delivery to ischemic tissue beds [10]. Although, In this study show the majority of nurses misunderstand about pediatric septic shock must have hypotension in the early clinical sign, in reality hypotension is not necessary for the clinical diagnosis of septic shock because this event occurs in the late stage of shock with ensuring circulatory collapse and failure is considering to have decompensate shock [21]. This study demonstrate the most of nurse have knowledge deficit about laboratory results such as Procalcitonin level are rapidly increased in children with sepsis and bacterial infection, blood glucose in normal range and hemoglobin threshold for blood transfusion. In reality may be due to nurse on busy, there are many orders for laboratory

require and Procalcitonin results are new knowledge for nurses. This was consistency with [17, 20] who report nurse on busy are unlikely to have the time to look at patient' blood result and some blood result that nurse would not be familiar with.

V. CONCLUSION

This study showed the critical care pediatric nurses were had a knowledge level for assessments and management of pediatric patient in the early stage of sepsis in a most medium level and were deficit several key area of SIRS/sepsis early recognition and management according to SSC current guideline. To recognize patient with sepsis and to implement the appropriate treatment, nurse on critical area need to be aware of the standard definition of sepsis and how it should be managed according to SSC current guideline to improve outcome and decrease mortality. The deficit in knowledge could result in a missed or delayed diagnosis of severe sepsis/septic shock and inappropriate and delayed management. Therefore, an educational intervention to increasing nurse' knowledge and established the clinical nursing practice guideline for pediatric care and prevention progressive of sepsis in pediatric patient will help to improve recognition and prompt aggressive management and ensuring the patient are given the best of care.

Limitations

The authors acknowledge that some of the questionnaire were not direct role of nurse but still overlaps the role of physician in the routine practice at this hospital such as fluid selection, inotrope drugs use, blood sampling etc.

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Conflict of interest

No conflict of interest has been declared by the authors.

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