

# A Comparison of Residents' Knowledge Regarding the Surviving Sepsis Campaign 2012 Guideline

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## Abstract

**Background:** Recently, Surviving Sepsis Campaign (SSC) guideline was updated. Our objective was to evaluate the knowledge of residents in different departments regarding the SSC 2012. **Methods:** A cross-sectional, descriptive self-questionnaire was distributed to interns and residents in the Departments of Internal Medicine, Surgery, and Emergency Medicine. **Results:** The response rate was 136 (89%) from 153 residents. The residents included 46 (33%) interns, 42 (31%) internal medicine residents, 41 (30%) surgical residents, and 7 (5%) emergency residents. Regarding the definitions of severe sepsis and septic shock, only 44 (32.4%) residents were able to differentiate the severity of sepsis. The surgical residents had a significantly lower rate of correct answers than that of internal medicine residents (12.2% vs. 45.2,  $P = 0.001$ ), emergency residents (12.2% vs. 57.1%,  $P = 0.005$ ), and interns (12.2% vs. 34.8%,  $P = 0.014$ ). Only 77 (51.5%) residents would measure blood lactate in patients with sepsis. In respect to the dose of fluid resuscitation, only 72 (52.9%) residents gave the recommended fluid (30 ml/kg) within the first 3 h. Surgical residents had a significantly lesser percentage of correct answers than that of internal medicine residents (29.3% vs. 69%,  $P < 0.0001$ ) and interns (29.3% vs. 60.8%,  $P = 0.003$ ). About 123 (90.4%) and 115 (84.6%) residents knew the appropriate targets for mean arterial pressure and vasopressors, respectively. Most residents could give antimicrobial drugs (73.5%) and steroids (93.4%) appropriately in the treatment of patients with septic shock. However, only half of the residents knew the target range of blood sugar control in patients with sepsis. **Conclusions:** Our residents' knowledge about the SSC 2012 is not satisfactory. Further instruction concerning sepsis management is required.

**Keywords:** Knowledge, resident, septic shock, severe sepsis, surviving sepsis campaign

## INTRODUCTION

Severe sepsis and septic shock are the major causes of morbidity and mortality in critically ill patients worldwide. Moreover, several studies have reported that the incidence of severe sepsis and septic shock is rising,<sup>[1-3]</sup> with overall hospital mortality rates of 24.2%–49.6% for severe sepsis<sup>[1-6]</sup> and 40.7%–54.1% for septic shock.<sup>[1,5,7]</sup> Severe sepsis and septic shock also have a major impact on health-care resources and economic costs.<sup>[2,8,9]</sup>

Over recent decades, there have been notable improvements in knowledge concerning the pathogenesis, diagnosis, and therapeutic care of sepsis. In 2004, a program called the Surviving Sepsis Campaign (SSC) was developed with the goal of reducing worldwide sepsis-related mortality.<sup>[10]</sup> The SSC guideline was updated for every 4 years with the latest version (SSC 2012) published in 2013.<sup>[11]</sup> Several studies have demonstrated that implementation of the SSC guideline

reduces the mortality rate and improves the quality of sepsis care.<sup>[12-15]</sup> Levy *et al.* reported that SSC performance bundles were associated with a 25% relative risk reduction in mortality rates and shortened Intensive Care Unit and hospital stays.<sup>[12]</sup> However, other studies from different countries around the world have also reported that compliance with the SSC guidelines was low.<sup>[5,13-17]</sup>

Earlier studies have shown that most physicians' knowledge concerning the SSC guideline is lower than expected.<sup>[17-20]</sup> A multicenter, case scenario-based online survey found that only 0.1% of physicians complied with all SSC resuscitation

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bundles.<sup>[17]</sup> Tufan *et al.* found that the knowledge of the SSC bundles of physicians in Turkey was negligible.<sup>[20]</sup> The question regarding fluid management on the survey was answered correctly by only 40% of the physicians. The residents of emergency, internal medicine, and surgical departments carry out the first and main responsibility for the management of patients with severe sepsis and septic shock. There have been few studies examining the knowledge of the residents in these departments concerning sepsis management according to the SSC guideline. Thus, we decided to conduct this study to evaluate and compare the knowledge of residents at our institution in southern Thailand during training regarding sepsis management according to the SSC 2012 recommendations.

## METHODS

This was a cross-sectional, descriptive, self-administered questionnaire study. The data were collected from November 2014 to March 2015. Our hospital, Songklanagarind Hospital, is an 854-bed tertiary care referral university teaching hospital at Prince of Songkla University, located in southern Thailand. The study population was drawn from residents training in our hospital, and included interns (transitional year), internal medicine residents, surgical residents, and emergency residents. The author visited and explained the objectives of the study to all interns and residents before the questionnaire was given to the participants to fill out on their own time. All interns and residents volunteered to participate in this study. This study was approved by our Institutional Review Board.

The questionnaire was developed by the authors based on the SSC 2012 guideline.<sup>[11]</sup> Three independent intensivists reviewed the questionnaire for appropriateness of the questions with the SSC 2012. The content was reviewed until achieving 100% correct answers.

The questionnaire consisted of six sections with a total of 15 questions [Appendix 1]. The first section comprised three questions. The objective of this section was to correctly identify patients with severe sepsis and septic shock. The first and second questions focused on and assessed the ability of residents to diagnose severe sepsis by organ dysfunction and high lactate, respectively. The third question assessed the resident's ability to diagnose septic shock.

The second section assessed the resident's performance to measure serum lactate level in the first 3 h. The third section assessed resident's knowledge regarding fluid resuscitation and early goal-directed therapy (EGDT). There were five questions in this section. The first question was a scenario of a patient coming to the emergency department (ED) with severe sepsis with blood lactate more than 4 mmol/L. The second question posed a case scenario of septic shock with severe hypotension. This was to determine how the residents would manage these patients. The third question was about the type of fluid resuscitation that should be selected for patients with sepsis. The last two questions in this section evaluated the residents' knowledge of EGDT. The fourth section was about vasopressor

therapy along with target mean arterial pressure (MAP). The fifth section consisted of miscellaneous content such as prompt antimicrobial administration, steroid use, and glucose control. The last section addressed the methods in the assessment of fluid status. No educational program was implemented before or during the survey period.

## Statistical analysis

The data are presented as percentages. Differences between groups or departments were analyzed by Pearson's Chi-square test.  $P < 0.05$  was considered statistically significant. Statistical analyses were performed using the STATA version 7 (StataCorp, College, Station TX, USA) and Excel (Microsoft, Redmond, WA, USA).

## RESULTS

The response rate was 136 (89%) from 153 residents and 69 (50.7%) were male. The details of the residents of our study are shown in Table 1. Twelve (9%) residents declared that their knowledge of the SSC 2012 guidelines was suboptimal. Of these 12 residents, 8 were interns, two were surgical residents, and the remaining two were emergency residents. However, all residents said that they had previously treated patients with severe sepsis and septic shock. Eighty-nine residents (65.4%) could correctly identify the latest version of the SSC guideline.

## Definition of sepsis, severe sepsis, and septic shock

The results showed that 76 (55.9%), 91 (66.9%), and 128 (94.1%) residents could correctly answer questions regarding the definitions of severe sepsis, sepsis with severe hypoperfusion (lactate  $>4$  mmol/L), and septic shock, respectively. However, only 44 (32.4%) residents were able to differentiate the severity of sepsis or understood the exact definitions of severe sepsis and septic shock [Figure 1]. In regards to the abilities of residents from the different departments to answer the questions correctly, it was found that surgical residents demonstrated a significantly poorer understanding of the definitions of severe sepsis and septic shock than the other departments and interns (compared with internal medicine residents, emergency residents, and interns

**Table 1: Details of the study population**

Residents	n (%)
Intern (transitional year)	46 (33.8)
Internal Medicine	42 (30.9)
1 <sup>st</sup> year	15 (35.7)
2 <sup>nd</sup> year	15 (35.7)
3 <sup>rd</sup> year	12 (28.6)
Surgical	41 (30.1)
1 <sup>st</sup> year	11 (26.8)
2 <sup>nd</sup> year	10 (24.4)
3 <sup>rd</sup> year	20 (48.8)
Emergency	7 (5.2)
2 <sup>nd</sup> year	5 (71.4)
3 <sup>rd</sup> year	2 (28.6)

at 12.2% vs. 45.2 [ $P = 0.001$ ], 12.2% vs. 57.1% [ $P = 0.005$ ], and 12.2% vs. 34.8% [ $P = 0.014$ ], respectively) [Figure 2].

### Lactate measurement

Seventy residents (51.5%) would measure blood lactate within the first 3 h of sepsis being diagnosed [Figure 1]. There were no statistically significant differences in knowledge of the correct management in this part between the departments and interns.

### Fluid resuscitation and early goal-directed therapy

All residents chose crystalloid as the initial fluid resuscitation. Most, i.e., 95.6% of the residents chose normal saline solution as their first choice, while the others (4.4%) chose Ringer's lactate solution. The knowledge concerning the choice of fluid resuscitation was equal when the departments were compared.

In the case scenario of a patient with sepsis who presented with hypotension, 101 (74.3%) residents recommended giving fluid (30 mL/kg) within the first 3 h. In another case scenario in which the patient presented with normal blood pressure but had lactate >4 mmol/L, only 74 (54.4%) residents recommended giving fluid up to 30 mL/kg within the first 3 h. In both of these scenarios, concerning the dose of fluid resuscitation, 72 (52.9%) residents gave the correct fluid administration according to the SSC guideline [Figure 1]. As to the initial fluid resuscitation, the surgical residents had a significantly lower percentage of correct answers than that of the internal medicine residents (29.3% vs. 69%,  $P < 0.0001$ ) and interns (29.3% vs. 60.8%,  $P = 0.003$ ) [Figure 2].

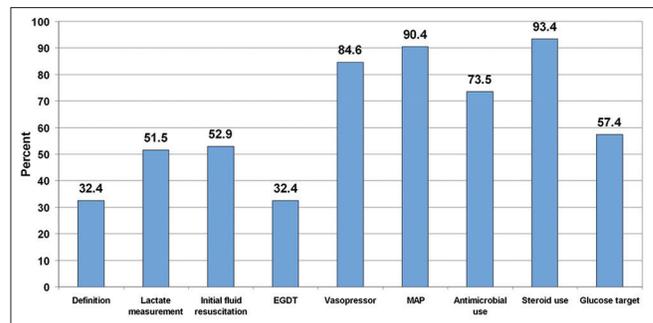
When asked about the correct use of the EGDT protocol, 95 (69.8%) residents understood the packed red cell transfusion protocol while 73 (53.7%) failed to recommend measuring central venous oxygen saturation after central venous pressure and MAP in target range. In summary, only 44 (32.4%) residents gave correct answers according to the EGDT protocol [Figure 1]. The emergency residents had a significantly higher score for the EGDT questions compared to internal medicine residents, surgical residents, and interns (85.7% vs. 21.4% [ $P = 0.001$ ], 85.7% vs. 36.6%, [ $P = 0.01$ ], and 85.7% vs. 30.4% [ $P = 0.005$ ], respectively) [Figure 2].

### Vasopressors and target mean arterial pressure

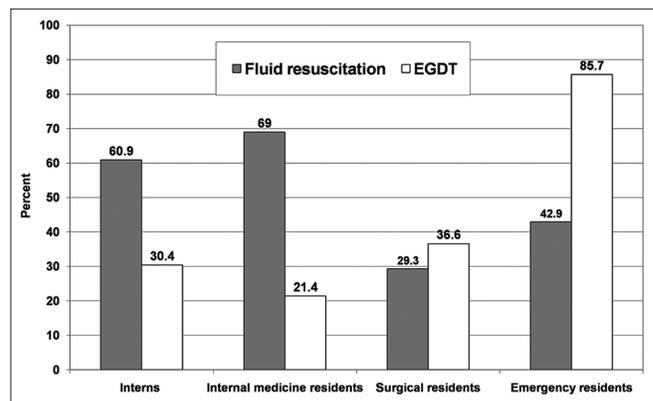
One hundred and fifteen residents (84.6%) used norepinephrine as the first vasopressor in patients with septic shock [Figure 1]. Most residents (90.4%) used a target MAP of 65 mmHg. There were no differences in knowledge concerning target MAP and vasopressors between the residents from the different departments and interns.

### Antimicrobial use, steroid use, and glucose control

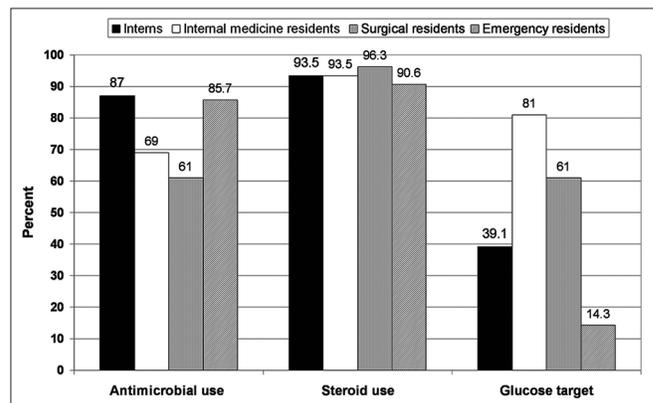
Most residents provided antimicrobial agents and steroids appropriately in patients with severe sepsis and septic shock (73.5% and 93.4%, respectively, Figure 1). The interns gave correct answers regarding the appropriate timing for administering antimicrobial agents according to the SSC 2012 guideline significantly more frequently than the internal medicine residents (87% vs. 69%,  $P = 0.04$ ) and surgical residents (87% vs. 61%,  $P = 0.005$ ) [Figure 3]. Only half of



**Figure 1:** Summary of percentage of correct answers. EGDT: Early goal-directed therapy, MAP: Mean arterial pressure.



**Figure 2:** Percentage of residents who answered questions on fluid resuscitation and early goal-directed therapy correctly, categorized by departments.



**Figure 3:** Percentage of residents who answered questions on antimicrobial use, steroid use, and glucose target control.

the residents (57.4%) knew the correct target range for blood sugar control in patients with sepsis. The internal medicine residents understood the correct glycemic control target better than surgical and emergency residents and interns (81% vs. 61%, [ $P = 0.04$ ], 81% vs. 14.3%, [ $P < 0.001$ ], and 81.0% vs. 39.1%, [ $P < 0.0001$ ], respectively) [Figure 3].

### Assessment of fluid responsiveness

Most residents (64.7%) chose CVP as the first tool for evaluating fluid responsiveness. Nine (6.6%) and 31 (22.8%) residents

chose the distensibility index of inferior vena cava and pulse pressure variation or stroke volume variation, respectively.

### Subgroup analysis

Residents who believed they had satisfactory knowledge of the SSC 2012 guideline used norepinephrine in septic shock significantly and more frequently than those who did not rate their knowledge as satisfactory (87.1% vs. 58.3%,  $P = 0.008$ ). However, there were no significant differences of the knowledge in other sections between those residents who declared optimal and suboptimal knowledge of the guideline. In addition, the residents' knowledge concerning the SSC 2012 recommendations was not related to their year of training, except in the area of prompt antimicrobial administration and target blood glucose control, in which the interns had a significantly higher percentage of correct answers about antimicrobial use than 2<sup>nd</sup> year residents and 3<sup>rd</sup> year residents (87% vs. 66.7%,  $P = 0.04$  and 87% vs. 56.2%,  $P = 0.002$ , respectively). In contrast, 1<sup>st</sup> and 2<sup>nd</sup> year residents had a better understanding of the correct blood glucose control target than interns (71% vs. 39.1%,  $P = 0.006$  and 74.1% vs. 39.1%,  $P = 0.004$ , respectively). In summary, from the overall scores, only two (1.5%) residents could answer all the questions contained in the questionnaire correctly.

## DISCUSSION

Overall knowledge of the residents from the three departments and interns in our institute regarding the SSC 2012 guidelines is unsatisfactory. Half of them showed limited knowledge regarding the definition of severe sepsis, lactate measurement, and proper dosaging of fluid resuscitation. Overall, the residents showed a good understanding of the SSC guideline in only three sections of knowledge about target MAP, vasopressor use, and appropriate steroid use.

We designed the questionnaire and gave it to our residents 2 years following the SSC 2012 publication. During those 2 years, there were several academic activities providing information about this guideline for the residents in our institute such as academic lectures, medical grand rounds, and topic reviews. In addition, there were various national education activities such as many academic meetings and congresses and the publication of a Thai clinical practice guideline for sepsis management. Thus, we expected that the residents in our institute would have adequate knowledge regarding the SSC 2012 guideline that would allow them to answer most of the questions correctly. In addition, we also expected that the senior residents would have better knowledge than the interns, it would be logical that the percentage of correct answers regarding any medical topic would improve through the years of training.

Concerning basic definitions, most of the residents could not differentiate severe sepsis from sepsis, and used the words synonymously. Only 55.9% of the residents could diagnose severe sepsis by organ dysfunction. These results

corresponded with previous studies. Ziglam *et al.* showed that only 48% of training-level doctors were able to identify severe sepsis correctly.<sup>[21]</sup> Assunção *et al.* reported that only 56.7% of physicians were able to properly diagnose severe sepsis.<sup>[19]</sup> However, the characteristics of the populations in these two studies were different. The population, from the Assuncao's study, were residents, surgeons, anesthesiologists, internists, and medical specialists. Our study showed that one-third of the residents could not identify sepsis with severe hypoperfusion (high lactate level). This result is consistent with a previous study which found that merely 32.3% of the physicians in Turkey could correctly identify the blood lactate threshold.<sup>[20]</sup> Nevertheless, most of the residents (94.1%) could identify patients with septic shock correctly. We found that residents relied primarily on low blood pressure to identify a low perfusion state in patients with sepsis. Delaying the diagnosis of severe sepsis and severe hypoperfusion may lead to delayed management.

In regards to the blood lactate section of the questionnaire, only 51.5% of the residents said they would measure blood lactate when a patient came to the ED with clinical symptoms of severe sepsis. This finding is similar to a study by Reade *et al.*, in which 46.5% of the physicians said they would measure blood lactate.<sup>[17]</sup> On the other hand, 74.9% and 81.4% of physicians in Turkey<sup>[20]</sup> and Japan,<sup>[5]</sup> respectively, indicated that they measured blood lactate level in patients with severe sepsis. Currently, the blood lactate level is accepted as an indicator of tissue perfusion. Despite stable blood pressure, patients with sepsis may have a high blood lactate level and require fluid resuscitation.<sup>[11]</sup> Delaying the performance of a blood lactate measurement can thus delay identifying sepsis in a timely way, and thus delay resuscitation and proper management.<sup>[11,22]</sup>

Early and aggressive fluid resuscitation has been recommended for management in patients with severe sepsis and septic shock.<sup>[11]</sup> However, only 74.3% and 54.4% of the residents would give fluid as recommended by the SSC in sepsis with hypotension and hypoperfusion, respectively. This demonstrated that the blood lactate level did not change their management style, and that their blood lactate interpretation is not satisfactory. Delayed management in fluid resuscitation, especially in patients with poor tissue perfusion and a high blood lactate level, is associated with increased morbidity and mortality in patients with sepsis.<sup>[22]</sup>

The residents in our study showed better knowledge of MAP target, steroid use, and glucose control, when compared with previous studies. Tufan *et al.* reported that only 58.3% of residents and physicians understood target MAP correctly.<sup>[20]</sup> Fernández *et al.* showed that physicians in Puerto Rico had ineffective knowledge about the use of steroid and glucose control in patients with sepsis.<sup>[18]</sup>

There were differences in residents' knowledge of the SSC guidelines when compared between departments. The internal medicine residents showed more knowledge than the other residents questioned, especially in the definitions of severe

sepsis and septic shock, proper doses of fluid resuscitation, and glycemic control. The residents from the ED were more likely to correctly follow the EGDT protocol than the other residents. These differences may be due to different opportunities and experience to treat patients with sepsis. When the data regarding the knowledge of residents were separately analyzed, based on year of training, no differences were noted. Surprisingly, the interns demonstrated a significantly better understanding of sepsis definitions, intravenous fluid resuscitation, and early use of appropriate antibiotics than the senior residents.

We believe that our study adds more confirmation to the various studies indicating the limitations of knowledge of residents regarding the SSC sepsis guidelines. Academic lectures or presentations of the guideline seem to have failed to improve or maintain residents' knowledge on these recommendations. Multimodalities of teaching and learning should be provided to improve medical knowledge in sepsis care process. Li *et al.* reported that a medical simulation course can increase residents' knowledge concerning the SCC guidelines.<sup>[23]</sup> Smartphone applications or case-based online games<sup>[24]</sup> may be effective tools with other teaching modalities to improve residents' knowledge of the SSC guideline.

In the assessment of fluid responsiveness, CVP was the first choice of most residents. However, several studies have found that CVP cannot indicate fluid status or fluid responsiveness properly.<sup>[25,26]</sup> The new consensus suggested that dynamic parameters, which represent fluid responsiveness correctly, should replace the current static parameters.<sup>[27]</sup> Despite the new evidence, only 29.4% of the residents chose dynamic parameters. This result is similar to the findings from previous studies.<sup>[28,29]</sup>

There were some limitations in this study. First, it was a single-center study, the site is a tertiary referral university teaching hospital, and the results may not apply to other hospitals. Second, the small number of residents from ED may have limited knowledge in comparison with residents from other departments. Finally, the questionnaire that was used in this study was constructed using acceptable methods of questionnaire construction; it measured only theoretical knowledge, and the practices of the residents in a real-time situation may not be the same. That being said, the answers may still be interrupted as a reflection of their knowledge that may be an important step before management.

## CONCLUSIONS

Most residents in our institute, who are normally responsible for patients with sepsis lack knowledge of the SSC 2012 guidelines, especially in the areas of correctly identifying sepsis severity, lactate measurement and interpretation, and initial fluid resuscitation. Repeated teaching, coupled with multimodal learning processes of sepsis management, should be further provided. This is particularly important since improvements in knowledge will certainly lead to a decrease in morbidity and mortality rates in patients with sepsis.

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## Conflicts of interest

There are no conflicts of interest.

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### Appendix 1: Questionnaire about the Surviving Sepsis Campaign 2012

Section	Question	Aim
1	1	Diagnosing severe sepsis by organ dysfunction
	2	Diagnosing severe sepsis with severe hyperperfusion (high lactate)
	3	Diagnosing septic shock
2	4	Lactate measurement
3	5	Fluid resuscitation in patients with severe sepsis and severe hyperperfusion (high lactate)
	6	Fluid resuscitation in patients with septic shock
	7	Type of initial fluid resuscitation
	8	Early goal-directed therapy – packed red cell transfusion
	9	Early goal-directed therapy – dobutamine infusion
4	10	Vasopressor therapy
	11	Target mean arterial blood pressure
5	12	Timing of antibiotics therapy
	13	Indication of steroid use
	14	Target glucose control
6	15	Assessment of fluid responsiveness