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ORIGINAL ARTICLE

Compliance and barriers to implementing the sepsis resuscitation bundle for patients developing septic shock in the general medical wards

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Background/Purpose: This two-part study aimed to investigate compliance with the sepsis resuscitation bundle (SRB) and the barriers to its implementation for patients developing septic shock in the general medical wards.
Methods: In the first part, medical records of patients who were admitted to the intensive care unit from the general medical wards due to septic shock were reviewed. Compliance rates with the six SRB components were assessed. In the second part, responsible junior physicians (first-year and second-year residents) in the general wards and senior physicians (third-year residents and fellows) were randomly invited for questionnaire-based interviews.
Results: In the first part, during the 6-month study period, 40 patients were included. Overall compliance with the SRB within 6 h was only 2.5%, mainly due to femoral catheterization (42.5%) and the lack of measuring central venous oxygen saturation ($ScvO_2$). Delayed completion of SRB components contributed little to the low compliance rate. In the second part, based on the questionnaire results of 71 junior physicians and 64 senior physicians, the junior physicians were less familiar with the SRB guidelines, particularly regarding the meaning of $ScvO_2$ ($p = 0.01$) and management of low $ScvO_2$ ($p = 0.04$). Junior physicians were also more reluctant to measure the central venous pressure (CVP; $p = 0.04$) and the $ScvO_2$ ($p = 0.01$), and were also less confident with internal jugular vein or subclavian vein catheterization ($p < 0.001$).

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Conclusion: Compliance with the SRB for patients developing septic shock in the general medical wards is very low. Besides providing educational programs to improve awareness and acceptance of the SRB, measures to help in central venous catheterization and completion of SRB may be considered.

Introduction

The incidence and rates of hospitalization for severe sepsis increase annually.[1,2] Severe sepsis remains the leading cause of death in non-cardiac intensive care units (ICUs) despite advances in intensive care.[3] Mortality rates for severe sepsis range from 30 to 50%, while those for septic shock range from 50 to 60%.[4,5] To improve sepsis care and reduce mortality, the Surviving Sepsis Campaign and the Institute for Healthcare Improvement have teamed up to incorporate a 6-h sepsis resuscitation bundle (SRB) and a 24-h management bundle into diagnosis and management of severe sepsis and septic shock.[6,7]

Early goal-directed therapy, together with early appropriate antibiotic therapy, is the core of SRB.[8,9] The implementation of these evidence-based clinical practice guidelines has shown survival benefits.[10–14] The degree of reduction in mortality also correlated with the numbers of bundle components achieved within a given short period.[13] However, compliance with each bundle component varies greatly, with achievement of central venous oxygen saturation ($ScvO_2$) $\geq$70% as the least completed.[15] The complexity, invasiveness, and required team approach of SRB are believed to make it difficult for medical staff to complete the interventions within 6 h following diagnosis.[16,17]

Research to date has tended to focus on implementation of SRB in the emergency service setting. For patients who develop severe sepsis or septic shock after their admission to the general wards, bundle compliance and barriers to SRB implementation are less well studied. This study therefore aimed to investigate the compliance with the SRB for patients developing septic shock in the general medical wards, as well as the barriers to its implementation.

Materials and methods

Hospital

This study was conducted at the National Taiwan University Hospital, a 2150-bed tertiary teaching hospital in northern Taiwan that has 441 medical general beds and 44 medical ICU (MICU) beds. During the academic year 2007–2008, the department of internal medicine had 139 residents (including first-, second- and third-year residents) and 56 fellows. The hospital's institutional review board approved the study protocol and waived the need for informed consent because of the retrospective design and the fact that interviews were only done with only healthcare workers.

Compliance with the SRB

The study process included two parts. The medical records of MICU patients admitted due to septic shock diagnosed in the general medical wards from January to June 2007 were reviewed. The diagnoses of septic shock were confirmed after chart review based on the definition in the Surviving Sepsis Campaign guidelines.[7] Briefly, sepsis was defined as infection plus systemic manifestations of infection. Sepsis-induced hypotension was defined as a systolic blood pressure $<$90 mm Hg or mean arterial pressure $<$70 mm Hg, or systolic blood pressure decrease $>$40 mm Hg or less than two standard deviations below normal for age in the absence of other causes of hypotension. Septic shock was defined as sepsis-induced hypotension persisting despite adequate fluid resuscitation. Because patients who develop signs of systemic inflammatory response syndrome may not progress to severe sepsis and the exact time of progression into severe sepsis is often not detected until hypotension has set in, the onset of persistent hypotension was defined as the starting point of the 6-h SRB in this study.

Patients were excluded if a "do-not-resuscitate" order was taken within 6 h of the development of septic shock, if an additional cause of shock was identified (e.g., cardiogenic, anaphylactic, or drug-related shock), or if the patients or their surrogates declined any SRB component.

The following data were collected for each patient: age, gender, co-morbidities, Acute Physiology and Chronic Health Evaluation (APACHE) II score, origin of infection, laboratory and microbiological data, time of diagnosis of septic shock and MICU admission, time of central venous catheter (CVC) placement, time of the six SRB interventions that were accomplished within 6–24 h following septic shock, and MICU outcomes. Of the six interventions, if the patients already received antibiotics and blood culture collections before the onset of septic shock, these two interventions were defined as instituting "new" broad-spectrum antibiotics after the onset of septic shock and "repeating" blood culture collection before new antibiotics.

Barriers to implementation of the SRB

To further investigate the barriers of SRB implementation, the second part assessed physician compliance to the bundle using a specially designed questionnaire (Appendix 1, originally in Chinese). Since a previous study showed that $ScvO_2$ and central venous pressure (CVP) were the least completed components of the SRB,[15] there was a focus on the experience and attitude to replacement of the CVC and monitoring of CVP and $ScvO_2$. With the questionnaire, the responsible junior physicians (first- and second-year

physicians) in the general ward and the senior physicians (third-year physicians and fellows) were randomly invited for an interview to assess their awareness, acceptance, and experience in complying with the SRB.

Statistical analysis

Results were expressed as mean ± standard deviations for continuous variables and numbers and percentages for categorical variables. Between-group differences were evaluated using the Chi-square test or fisher's exact test, where appropriate. A two-sided $p < 0.05$ was considered statistically significant. All statistical analyses were performed with the software SPSS version 15 (SPSS Inc., Chicago, IL, USA).

Results

From January to June 2007, among the 750 patients admitted to the MICU, 346 were from the general medical ward. Only 40 patients were included in this study; their clinical characteristics are shown in Table 1. The mean time from diagnosis of septic shock to MICU admission was 10.1 ± 9.7 h while the median time was 6.3 h (range 1.5-37.8 h). Pneumonia (57.5%) was the most common infection associated with septic shock. Mortality rates of these 40 patients in the MICU and upon hospital discharge were 60% and 80%, respectively.

Compliance rates to the six interventions of SRB and the performance of CVC replacement within 6 h and beyond following septic shock are shown in Table 2. The bundle of broad-spectrum antibiotics was achieved in 31 (77.5%) patients. The other nine patients (22.5%) had already received antibiotics upon admission and did not receive new antibiotics after the onset of septic shock. The least achieved interventions were $ScvO_2$ ≥70% and CVP ≧ 8 mm Hg (2.5% and 20%, respectively). Overall compliance to the SRB was 2.5%.

Table 1 Clinical characteristics of patients with septic shock diagnosed in the medical general ward.

Characteristic	Patients (n = 40)
Age (y), mean ± SD	63.5 ± 16.0
Sex (male), n (%)	27 (67.5)
APACHE II score, mean ± SD	29.6 ± 7.2
Time to ICU transfer (h), mean ± SD	10.1 ± 9.7
Co-morbidity, n (%)	
Malignancy	27 (67.5)
Diabetes mellitus	11 (27.5)
Hypertension	10 (25.0)
Chronic renal insufficiency	8 (20.0)
Chronic pulmonary disease	7 (17.5)
Cardiovascular disease	7 (17.5)
Origin of infection, n (%)	
Pneumonia	23 (57.5)
Intra-abdominal infection	12 (30.0)
Others	5 (12.5)
Positive blood culture, n (%)	21 (52.5)
Hospital mortality, n (%)	32 (80.0)

Of the 28 (70%) patients with new CVC replacement, 17 (42.5%) received femoral catheterization. Another three received internal jugular vein (IJV) catheterization and six had femoral vein (FV) catheterization before the diagnosis of septic shock to receive chemotherapy or total parenteral nutrition. Of the 14 (35%) patients with an IJV or subclavian vein (SV) catheter, CVP measurement was performed in 13 (32.5%) and $ScvO_2$ measurement was only done in two (5%) patients. Beyond 6 h and up to 24 h, one more patient received IJV catheterization, two more achieved the CVP goal, and no additional patient achieved the $ScvO_2$ goal.

Of the 40 patients, 19 patients (47.5%) were transferred to ICU within 6 h following septic shock. Within 24 h following septic shock, one patient received IJV catheterization in the MICU while 11 patients received IJV or SV catheterization in the general wards. Five patients achieved the CVP goals in the MICU and five patients in the general wards. Only one patient achieved the $ScvO_2$ goal in the MICU.

In the second part of the study, 71 junior and 64 senior physicians completed the questionnaire-based interview between August 2008 and September 2008. Table 3 summarizes the results regarding their awareness, acceptance, and experience on SRB. Junior physicians were less familiar with the SRB guidelines, especially regarding the use of $ScvO_2$ ($p = 0.01$) and managing low $ScvO_2$ ($p = 0.04$). Although almost all recognized the importance of IJV or SV catheterization, junior physicians were more reluctant to measure the CVP ($p = 0.04$) and the $ScvO_2$ ($p = 0.01$). Junior physicians were less confident with IJV or SV catheterization ($p < 0.001$).

Discussion

In this study, compliance with the SRB for patients who developed septic shock in the general medical wards was very low, mainly due to the lack of $ScvO_2$ measurement. This finding is similar to the reports by Levy et al. and Ferrer et al., who reported that ScvO2 ≥70% is the least achieved goal in the management of severe sepsis.[14,15] Moreover, the main barriers to SRB implementation were poor awareness and acceptance of its bundle (particularly with the $ScvO_2$), which may result in neglect of the importance of central venous catheterization in the neck.

Since the SRB stresses its components must be completed within 6 h of diagnosis, causes of failure may include a delay in identification of severe sepsis or septic shock, and a poor coordination in patient management.[17] In this study, the median time from the general ward to the ICU was 6.3 h. The availability of ICU beds and the transport of patients between the wards and the ICU may hinder the patient from receiving timely treatment regarding SRB components. However, compliance improves to some degree beyond 6 h and after MICU admission, suggesting that time delay is not the sole problem.

Most patients received timely CVC replacement, fluid challenge, and vasopressor use to maintain adequate blood pressure. However, more than half of the newly-established

Table 2 Compliance with the sepsis resuscitation bundle and performance of central venous catheterization.

Intervention	Within 6 h		6–24 h	
	N (%)	Time required (min), mean ± SD	N (%)	Time required, (min), mean ± SD
Sepsis resuscitation bundle				
Measure lactate	24 (60.0)	179 ± 134	9 (22.5)	771 ± 366
Blood culture before antibiotics	25 (62.5)	138 ± 106	4 (10.0)	775 ± 348
Broad-spectrum antibiotics	31 (77.5)	150 ± 106	4 (10.0)	533 ± 124
Fluids and vasopressors to keep MAP ≥65 mm Hg	32 (80.0)	114 ± 92	4 (10.0)	603 ± 413
Central venous pressure ≥8 mm Hg	8 (20.0)	317 ± 61	2 (5.0)	690 ± 311
Central venous oxygen saturation ≥ 70%	1 (2.5)	360	0 (0)	
Replacement of a new central venous catheter	28 (70.0)	143 ± 104	1 (2.5)	640
Internal jugular vein or subclavian vein	11 (27.5)	177 ± 84	1 (2.5)	640
Femoral vein	17 (42.5)	121 ± 113	0(0)	

MAP, mean arterial pressure.

CVCs were on the FV, making further CVP and $ScvO_2$ monitoring impossible. In addition, $ScvO_2$ was less checked than CVP in patients who received IJV or SV catheterization. CVP measurements were routinely performed (every 2 h) in the MICU of the study hospital, which may explain the higher compliance rate.

Based on the questionnaire results of junior physicians, awareness and acceptance of $ScvO_2$ monitoring is poorer than fluid resuscitation and vasopressor use. The patients in this study might have adequate perfusion after fluid resuscitation and vasopressor use, and not monitoring the $ScvO_2$ is not necessarily the same as not achieving the goals. However, Rady et al. observed that half of the patients with shock still have inadequate microvascular tissue perfusion despite stable vital signs normalized by resuscitation.[18] The concept of monitoring $ScvO_2$ as a guide for further management should be emphasized.

From the questionnaire results, almost all of the physicians understand the use of IJV or SV catheterization. However, when encountering a patient with septic shock, junior physicians tended to perform femoral catheterization due to its low technical requirement. Both junior and senior physicians might choose femoral catheterization to avoid compromising respiration and risk of life-threatening pneumothorax or hemothorax. A few physicians even deferred a CVC replacement due to the shortage of time or nursing staff. In the study hospital, primary care physicians in the general medical ward are junior physicians

Table 3 Barriers to implementing the sepsis resuscitation bundle in general medical wards.

	Junior Physician (n = 71), n (%)	Senior physician (n = 64), n (%)	*p* value
Familiarity with the SRB			
Ideal CVC site: IJV or SV	71(100)	64 (100)	
Fluid resuscitation and vasopressor use	53 (74.6)	51 (79.7)	0.49
Meaning of $ScvO_2$	64 (90.1)	64 (100)	0.01
Managing low $ScvO_2$	35 (49.3)	43 (67.2)	0.04
Acceptance of the SRB			
Agree with IJV or SV catheterization	69 (97.2)	64 (100)	0.50
Agree with CVP monitoring	63 (88.7)	63 (98.4)	0.04
Agree with $ScvO_2$ monitoring	39 (54.9)	49 (76.6)	0.01
To establish an new IJV or SV catheter if a FV catheter is present	17 (23.9)	42 (65.6)	<0.001
Experience			
Confident in IJV or SV catheterization	39 (54.9)	57 (89.1)	<0.001
Confident in FV catheterization	61 (85.9)	60 (93.8)	0.17
Ever established a FV catheter for the concern of compromising respiration	37 (52.1)	40 (62.5)	0.22
Ever established a FV catheter for the concern of life-threatening complication	54 (76.1)	39 (60.9)	0.06
Ever deferred a CVC replacement due to shortage of time	11 (15.5)	11 (17.2)	0.79
Ever deferred a CVC replacement due to shortage of nursing staff	12 (16.9)	14 (21.9)	0.46

SRB, sepsis resuscitation bundle; CVC, central venous catheter; IJV, internal jugular vein; SV, subclavian vein; $ScvO_2$, central venous oxygenation; CVP, central venous pressure; FV, femoral vein.

supervised by senior staff. These findings may explain the low rate of IJV or SV catheterization in this study.

In this study, the hospital mortality was up to 80%. In addition to the high percentage of underlying malignancy in the study population, the APACHE II score of the patients was 29.6 $\pm$ 7.2, which was also higher than in previous studies.[4,5] Both factors may result in the high hospital mortality rate.

This study has several limitations. First, the use of persistent hypotension as the starting point of the 6-h resuscitation duration does not fully approximate the real scenario. A time gap may exist between the onset of severe sepsis and the diagnosis of septic shock, and SRB components should be performed earlier. Second, the study hospital had no written protocol for management of patients with septic shock in the general medical ward during the study period. Numerous studies have demonstrated that education programs or implementation of quality indicators is a basic requirement to improve the awareness and acceptance of SRB and is essential to sustainability.[12,13,15,19,20] However, this study was not designed to address the "before and after" effect but to investigate the possible barriers. Lastly, this study may be more persuasive if more patients were included. However, the low compliance rate of achieving optimal $ScvO_2$ was not only observed in this study; the reports by Levy et al. and Ferrer et al. also demonstrate the similar findings.[14,15]

In teaching hospitals, there are new junior physicians in the general ward every year. During the period in which new junior physicians are rapidly learning their clinical performance, a more practical approach is required to implement the SRB for patients developing septic shock in the general ward. Recently, introduction of a medical emergency team demonstrated survival benefit for non-ICU hospitalized patients.[21] Since obstacles to implementation of SRB include complexity and invasiveness of the bundle components, the employment or deployment of experienced senior staff may help in timely IJV or SV catheterization, accurate completion of the SRB components, and enhancement of the coordination between the general ward and the ICU.

Another practical implication of this study is the use of $ScvO_2$. The achievement of $ScvO_2$ $\geq$70% was proved to be the only single bundle component associated with a reduction in mortality.[13] Compared with continuous fiberoptic monitoring, a single measurement of $ScvO_2$ by blood spot sampling is feasible in the general medical ward and may serve as an indicator. If the spot $ScvO_2$ is $<$70%, early transfer of the patient to the ICU is strongly advised.

Conclusions

This study showed that compliance with the SRB for patients developing septic shock in the general medical ward is low. The achievement of $ScvO_2$ $\geq$70% is the least completed component. Education programs must be provided to improve the awareness and acceptance of the SRB, particularly with $ScvO_2$ monitoring. Meanwhile, measures to help in central venous catheterization and accurate completion of the SRB components should be considered. Further investigations are also needed to accumulate more evidence regarding SRB implementation in the general ward setting.

Appendix 1 Questionnaire

1. Years in clinical practice
   - First-year resident
   - Second-year resident
   - Third-year resident
   - Fellow, subspecialty: _____

Familiarity with the SSC management guidelines

2. What would you do when you encounter a patient with septic shock?
   - Fluid challenge only
   - Immediate vasopressor use
   - Fluid challenge first; if poor response, add vasopressor use
3. What is the ideal CVC site for CVP and $ScvO_2$ monitoring?
   - Subclavian or internal jugular vein
   - Femoral vein
4. Do you understand the use of $ScvO_2$ for detecting microvascular tissue hypoperfusion?
   - Yes
   - No
5. Which management can increase $ScvO_2$ after mean arterial pressure is normalized by fluid resuscitation and vasopressors use?
   - Transfusion to keep the hematocrit $\geq$30%
   - Dobutamine use
   - Both

Acceptance of the SSC management guidelines

6. Do you agree with placement of an IJV or SV CVC for patients with septic shock in the general medical ward?
   - Yes
   - No
7. Do you agree with monitoring of the CVP for patients with septic shock in the general medical ward?
   - Yes
   - No
8. Do you agree with measurement of the $ScvO_2$ for patients with septic shock in the general medical ward?
   - Yes
   - No

Personal experience in complying with the SSC management guidelines

9. Are you confident/comfortable in establishing an IJV or SV CVC?
   - Yes
   - No
10. Are you confident/comfortable in establishing an FV CVC?
    - Yes
    - No

11. Have you ever established an FV CVC instead of an IJV CVC because you are concerned about compromising respiration?
    - Yes
    - No
12. Have you ever established an FV CVC instead of an IJV CVC because you are concerned about life-threatening pneumothorax/hemothorax?
    - Yes
    - No
13. Have you ever deferred a CVC replacement in the general ward due to shortage of time and pending ICU transfer?
    - Yes
    - No
14. Have you ever deferred a CVC replacement in the general ward due to shortage of nursing staff to assist?
    - Yes
    - No

SSC, Surviving Sepsis Campaign; CVC, central venous catheter; CVP, central venous pressure; $ScvO_2$, central venous oxygen saturation; IJV, internal jugular vein; SV, subclavian vein; SRB, sepsis resuscitation bundle; FV, femoral vein.

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