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Original Article

Emergency Physician Compliance with Quality Indicators of Septic Shock and Severe Sepsis in Eastern Taiwanese Community Hospital

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Background: A retrospective review was conducted, examining patient charts at a community hospital in Eastern Taiwan during a 2-year period, from April 2013 to March 2015.
Aims: The goal was assessment of adherence to quality indicators (QIs) in septic shock and severe sepsis (4S status) by emergency physicians (EPs).
Methods: Based on the Surviving Sepsis Campaign (SSC) guidelines, data was electronically retrieved from the Hospital Information System (HIS); and beginning in April 2014, our staff was regularly educated on this topic during monthly meetings. A Sepsis Bundle Care Set (SBCS) was also launched in September 2014. The Chi-square post hoc test was utilized in statistical analysis, setting significance at $p < 0.05$. In patients with septic shock (n = 81) or severe sepsis (n = 572), QIs before and after educational initiatives were 36 vs. 45 and 259 vs. 313, respectively.
Results: In terms of septic shock, QIs that improved significantly after education were C-reactive protein (CRP: 66.67% vs. 91.11%), arterial blood gas (ABG: 58.33% vs. 80.00%), and intravenous (IV)-fluid infusion rate (0.00% vs. 40.00%). QIs that significantly improved in the context of severe sepsis were CRP (59.46% vs. 84.66%), serum lactate (75.68% vs. 86.26%), intensive care unit (ICU) admission within 4 hours (72.97% vs. 81.79%), and IV-fluid infusion rate (0.00% vs. 18.85%). In comparing QI adherence rates by educational period subsets, two-set IV line showed significant improvement after 7 months of education, and admission to ICU within 4 hours after 4 months of education. However, most QIs associated with severe sepsis (except serum lactate and antibiotic given in 1 hour) showed significant improvement after 3 months of education.
Conclusions: We concluded that there is much room to improve QI adherence rates in patients with 4S status, using educational initiatives.

Key words: *bundled care, quality indicators, quality assurance, septic shock, severe sepsis*

Introduction

Quality assurance is the process of maintaining a minimum acceptable level of excellence in products or services offered by an organization. Hence, many quality indicators (QIs) have been established

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to monitor the care rendered in each hospital facility. The accreditation process is focused on QIs in three major diseases: acute coronary syndrome,[1] acute ischemic cerebral vascular accident, and major trauma. The data collected in turn help improve or maintain the standard of care provided.

Although not yet adopted by accreditation agencies in Taiwan as a fourth condition, the Surviving Sepsis Campaign (SSC) guidelines issued in 2012 maintain that many QIs are similarly useful in treating patients with severe sepsis and septic shock (4S status)[2]. There may be some reluctance to do so, fearing that QIs in 4S status could reflect poorly. However, the consensus within Taiwan on QIs in this setting is virtually unknown, and few papers have addressed this issue in recent years.[3,4]

The purpose of this study was to define the present position on QIs for 4S patients in a community hospital setting of Eastern Taiwan and formulate a strategy for improvement. The period needed to educate emergency physicians (EPs) is also a concern, warranting further investigation via study subsets.

Materials and Methods

A retrospective chart review was conducted between April 2013 and March 2015, examining records within a community hospital of Eastern Taiwan. All adult patients (≥ 18 years old) admitted with 4S status via the emergency department (ED) were included in this study.

Medical records in our ED have been fully computerized, entering all medical order requisitions into the Hospital Information System (HIS). QIs were thus easily monitored by selecting two specific time points. In accord with SSC guidelines of 2012, several critical QIs served as study parameters. However, to simplify matters, we excluded some variables, such as blood culture (B/C), chest x-ray (CXR), and complete blood count/differential count (CDC/DC), viewed by our EPs as routine tests in daily practice. Instead, our focus was on various exams and procedures generally done less often. In non-genitourinary infections, routine urinalysis and urine culture were unwarranted, thereby removing them from scope of study. On the other hand, routine placement of Foley catheters and setup of two IV lines were debatable. Most EPs felt that including these in severe sepsis without shock would be meaningless as QIs. This premise awaits further proof, but for now, we rejected these procedures as QIs in 4S patients.

The data collected included patient age, gender, diagnosis, time of ED registration, timing of antibiotics given, and various laboratory studies, such as arterial blood gas (ABG), C-reactive protein (CRP), and serum lactate. Patients were also checked for insertion of two intravenous (IV) lines, Foley catheter insertion, and admission to the Intensive Care Unit (ICU) within 4 hours. A research assistant calculated and recorded IV-fluid infusion rates (according to nursing records), indicating whether initial administration of crystalloid (30 mL/kg) was achieved as a fluid challenge. Central venous catheter (CVC) placement within the ED was not strictly stipulated, given the time required and overall quality of CVC placement by ED staff. Consequently, CVC placement at ED within 6 hours was not analyzed, although admission to ICU within 4 hours was strongly encouraged.

Awareness of sepsis guidelines has been promoted during our monthly staff meetings since April 2014. We urged that EPs adhere strictly to SSC 2012 guidelines whenever a diagnosis of 4S was rendered. At the same time, efforts have concentrated on the expeditious transfer all such patients to ICU. Each month, all patients with 4S status are then discussed and QIs examined. In instances where patient QIs proved substandard, reminders were sent to responsible EPs, repeating those reminders monthly during staff meetings. In addition, the Department of Information Technology was tasked with designing a Sepsis Bundle Care Set (SBCS), which was completed in September 2014. The SBCS was set to automatically pop up in a window, once the 4S ICD-9 code was assigned. A menu of all related QIs was also generated upon execution, with pop-up notices reminding doctors to administer antibiotics as soon as possible or to undertake ICU admission within 4 hours. We consistently promoted SBCS use to avoid omission of any QIs. Even in patients diagnosed as 4S well past ED arrival, physician use of SBCS was still advised. Reminders released through SBCS were issued each month during our staff meeting.

The patients studied were stratified into two groups, according to timing of our educational initiative (before vs. after). This corresponded with April 2013 to March 2014 and April 2014 to March 2015, respectively. To define required educational periods, five patient subsets were ultimately established as follows: (1) pre-education period (January-March 2014), (2) 1-3 months of education (April-June 2014), (3) 4-6

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months of education (July-September 2014), (4) 7-9 months of education (October-December 2014), and (5) 10-12 months of education (January-March 2015).

To gauge the effectiveness of our educational efforts, we compared QI adherence rates before and after instituting staff education. The Chi-square post-hoc test was applied, setting statistical significance at $p < 0.05$.

Results

Overall, 81 patients with septic shock and 572 with severe sepsis accrued during the studied period, generating QIs of 36 vs. 45 and 259 vs. 313, respectively before and after educational initiatives. Comparisons are summarized in Table 1. The two worst performance parameters in patients with septic shock were IV-fluid infusion rate and Foley catheterization, both of which clearly improved through education (0.00% vs. 40.00% and 41.67% vs. 57.78%, respectively). QIs in septic shock that showed statistically significant improvement were CRP, ABG, and IV-fluid infusion rate. The two worst performance parameters in severely septic patients were IV-fluid infusion rate and ABG analysis, again improving after education (0.00% vs. 18.85% and 55.98% vs. 61.66%, respectively). Other QIs in severely septic patients that showed statistically significant improvement were CRP, serum lactate, and ICU admission within 4 hours.

In patients with septic shock, QI adherence rate at different intervals in the educational period were compared. Two-set IV line showed significant improvement after 7 months of education and admission to ICU within 4 hours improved after 4 months of education (Table 2). Most QIs in severely septic patients improved significantly after 3 months of education, with exception of serum lactate and antibiotic given in 1 hour (Table 3).

Discussion

Prompted by SSC guidelines of 2004,[5] many sources now contend that "bundled care" will lower mortality rates in patients with 4S status,[6,7] amply documenting the benefits of such bundling in the medical literature.[8-17] In fact, this is a two-pronged strategy, including an initial management bundle (undertaken during the 6 hours after patient presentation at ED) and a management bundle (later achieved in ICU).[2] Certainly, all hospitals strive to uphold SBCS QIs, but much emphasis and effort has focused on aggressive fluid challenge and early administration of broad-spectrum antibiotics.[18-25] The real issue, however, is the capacity of doctors to distinguish 4S status and to comply with related SSC-supported QIs. According to overseas and limited local studies, adherence rates for these QIs are low,[3,10,26] and unfortunately, our data offer no contradiction.

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Table 1. Adherence rates of quality indicators in instances of septic shock and severe sepsis (4S) before and after educational initiatives

Quality indicators	Septic shock			Severe sepsis		
	before	after	*p*	before	after	*p*
Study numbers	36	45	0.425	259	313	0.023
Male:Female	22:13	26:19	0.645	133:126	188:125	0.035
Mean age	77.4	76.19		75.28	76.02	
Serum lactate	88.89%	93.33%	0.375	75.68%	86.26%	0.001
Antibiotic given in 1 hr	86.11%	77.78%	0.235	85.71%	84.35%	0.368
Admit to ICU w/in 4 hrs	83.33%	80.00%	0.465	72.97%	81.79%	0.008
IV line, 2 sets	75.00%	84.44%	0.217	-	-	
CRP	66.67%	91.11%	0.007	59.46%	84.66%	0.000
ABG	58.33%	80.00%	0.030	55.98%	61.66%	0.099
Foley use	41.67%	57.78%	0.112	-	-	
N/S rate (30 mL/kg in first 30 min)	0.00%	40.00%	0.000	0.000%	18.85%	< 0.001

ABG, arterial blood gas; CRP, C-reactive protein; ICU, intensive care unit; IV, intravenous; N/S, normal saline.

Table 2. Adherence rates of quality indicators in patients with septic shock by educational subsets

Quality indicators	Before	3 mo after	4-6 mo after	7-9 mo after	10-12mo after	*p* value
Study numbers	11	11	10	5	19	0.061
Male:Female	8:3	5:6	7:3	4:1	13:6	0.582
Mean age	74.6 ± 19.7	76.4 ± 13.1	79.7 ± 7.7	81.0 ± 10.1	75.1 ± 16.8	0.868
Serum lactate	100.00%	100.00%	80.00%	80.00%	100%	0.070
IV line, 2 sets	81.82%	90.91%	50.00%	80.00%	100%	0.013
CRP	81.82%	81.82%	90.00%	100%	94.74%	0.649
Antibiotic given in 1 hr	81.82%	72.73%	70.00%	100%	78.95%	0.719
Admit to ICU w/in 4 hrs	72.73%	45.45%	90.00%	100%	89.47%	0.028
Foley use	63.64%	63.64%	20.00%	60.00%	73.68%	0.085
ABG	54.55%	81.82%	60.00%	100%	84.21%	0.168
N/S rate (30 mL/kg in first 30 min)	0.00%	0.00%	20.00%	60.00%	68.42%	< 0.001

ABG, arterial blood gas; CRP, C-reactive protein; ICU, intensive care unit; IV, intravenous; mo, months; N/S, normal saline.

Table 3. Adherence rates of quality indicators in patients with severe sepsis by educational subsets

Quality indicators	Before	3 mo after	4-6 mo after	7-9 mo after	10-12mo after	*p* value
Study numbers	80	73	59	78	103	< 0.001
Male:Female	38:42	47:26	32:27	45:33	65:41	0.253
Mean age	77.2 ± 12.4	72.3 ± 16.9	73.3 ± 19.9	75.2 ± 14.4	74.8 ± 15.8	0.372
Serum lactate	85.00%	80.82%	84.78%	87.18%	92.23%	0.187
Antibiotic given in 1 hr	81.25%	79.45%	84.78%	85.90%	88.35%	0.483
CRP	67.50%	75.34%	84.78%	85.90%	90.29%	0.001
ABG	56.25%	49.32%	60.87%	62.82%	71.84%	0.035
Admit to ICU w/in 4 hrs	56.25%	76.71%	84.78%	92.31%	76.70%	< 0.001
N/S rate (30 mL/kg in first 30 min)	0.00%	0.00%	26.09%	21.79%	29.13%	< 0.001

ABG, arterial blood gas; CRP, C-reactive protein; ICU, intensive care unit; mo, months; N/S, normal saline.

4S) stipulate CVC placement within 6 hours.[2] Recent studies have also stressed maximal sterile-barrier precautions during catheter insertion,[27] although strict adherence to such mandates within the ED environment is difficult. We have instead advocated a more realistic approach, calling for ICU admission within 4 hours. ICU physicians are thus able to comply with a 6-hour limit for CVC placement, giving them at least 2 hours to do so. Some reports have further cautioned that "early goal-directed therapy" in the ED may not reduce mortality,[28,29] offering added support for our modification. We are otherwise aligned with all 2012 SSC directives.

Our study indicates that adherence rates for three QIs in patients with septic shock (IV-fluid infusion rate, Foley catheterization, and ABG analysis) are subpar, falling below 60%. Although education is beneficial, the former two QIs still fell short of 60%, reminding us that the urgency of rapid IV-fluid administration is a point worthy of repeated emphasis in EPs. In severe sepsis, not only fluid infusion but also ABG analysis merit re-education as well. This is especially true for some EPs who may confuse venous and arterial blood sampling. Education can do little to improve QIs in this context if an appreciation of fundamentals is lacking. Clearly, the onus is on residency programs to correct such deficiencies.

Table 2 presents data of patients with septic shock, underscoring that ongoing education and SBCS inception effected significant QI improvement only in terms of two-set IV line and admission to ICU within 4 hours. There was no impact on the two worst performance QIs. In examining the five study subsets, we see that patterns of most QIs fluctuated, likely due

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to vacillating study volume and even with online access to SBCS after 9 months.

Table 3 depicts the slightly different results for severe sepsis. The combined benefit of continuous education and SBCS access after 9 months shows significant increases in all QIs, with exception of serum lactate and antibiotic given in 1 hour. Although the latter trended toward QI adherence, no discernible change was evident within the first 6 months. Only admission to ICU within 4 hours unequivocally failed to improve, a finding we attribute to overcrowding of the ED and a dearth of ICU availability in our hospital. Such challenges will not be remedied through further education or SBCS prompts. It is also regrettable that IV hydration rates are not yet ideal. Going forward, these are problems that must be resolved.

Several study limitations are acknowledged. Patient numbers were small, recruited from a single institution. A large-scale study on this topic is imperative to acquire an evidence base for policy-making. Another weakness is that IV-fluid infusion rates were manually calculated, potentially introducing human error and skewing statistical results. An objective method for such calculations should be pursued. Finally, the impact of education and SBCS on clinical outcomes, such as hospital/ICU stay and patient mortality, were not explored. What's more, the QIs we used reflected the consensus of good practice at our institution and should not be extrapolated to other facilities.

In conclusion, there is much room to improve QI adherence rates in patients with 4S status. Ongoing education is critical, using technologic enhancements (such as SBCS) to deliver better quality of care. A large-scale crossover hospital study would be helpful in delineating future goals.

References

1. Hsieh DJ, Chen WK. Quality of care of patients presenting with acute coronary syndrome in emergency departments in Taiwan. *J Acute Med* 2011;1:33-40.
2. Dellinger RP, Levy MM, Rhodes A, et al. Surviving Sepsis Campaign: international guidelines for management of severe sepsis and septic shock: 2012. *Intensive Care Med* 2013;41:580-637.
3. Kuo YW, Chang HT, Wu PC, et al. Compliance and barriers to implementing the sepsis resuscitation bundle for patients developing septic shock in the general medical wards. *J Formos Med Asso* 2012;111:77-82.
4. Wang JL, Chin CS, Chang MC, et al. Key process indicators of mortality in the implementation of protocol-driven therapy for severe sepsis. *J Formos Med Asso* 2009;108:778-787.
5. Dellinger RP, Carlet JM, Masur H, et al. Surviving sepsis campaign guidelines for management of severe sepsis and septic shock. *Crit Care Med* 2004;32:858-873.
6. Nguyen HB, Corbett SW, Steele R, et al. Implementation of a bundle of quality indicators for the early management of severe sepsis and septic shock is associated with decreased mortality. *Crit Care Med* 2007;35:1105-1112.
7. Wang AT, Liu F, Zhu X, Yao GO. The effect of an optimized resuscitation strategy on prognosis of patients with septic shock: a systematic review. *Zhongguo Wei Zhong Bing Ji Jiu Yi Xue* 2012;24:13-17.
8. Zhou X, Liu D, Long Y, et al. Prognostic outcomes of adherence to guideline of bundle therapy by key points of control strategies in septic shock patients. *Zhonghua Yi Xue Za Zhi* 2014;94:994-998.
9. Seoane L, Winterbottom F, Nash T, et al. Using quality improvement principles to improve the care of patients with severe sepsis and septic shock. *Ochsner J* 2013;13:359-366.
10. Miller RR, Dong L, Nelson NC, et al. Multicenter implementation of a severe sepsis and septic shock treatment bundle. *Am J Respir Crit Care Med* 2013;188:77-82.
11. Coba V, Whitmill M, Mooney R, et al. Resuscitation bundle compliance in severe sepsis and septic shock: improves survival, is better late than never. *J intensive Care Med* 2011;26:304-313.
12. Lefrant JY, Muller L, Raillard A, et al. Reduction of the severe sepsis or septic shock associated mortality by reinforcement of the recommendations bundle: a multicenter study. *Ann Fr Anesth Reanim* 2010;29:621-628.
13. Pestana D, Espinosa E, Sanguesa-Molina Jr, et al. Compliance with a sepsis bundle and its effect on intensive care unit mortality in surgical septic shock patients. *J Trauma* 2010;69:1282-1287.
14. Van Zanten AR, Brinkman S, Arbous MS, et al. Guideline bundles adherence and mortality in severe sepsis and septic shock. *Crit Care Med* 2014;42:1890-1898.
15. Ferrer R, Artigas A, Levy MM, et al. Improvement in process of care and outcome after a multicenter Severe sepsis educational program in Spain. *JAMA* 2008;299:2294-2303.
16. Levy MM, Dellinger RP, Townsend SR, et al. The surviving sepsis campaign: results of an international guideline-based performance improvement program targeting severe sepsis. *Crit Care Med* 2010;38:367-374.
17. Walkey AJ, Wiener RS, Lindenauer PK. Utilization patterns and outcomes associated with central venous catheter in septic shock: a population-based study. *Crit Care*

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Med 2013;41:1450-1457.
18. Yokota PK, Marra AR, Martino MD, et al. Impact of appropriate antimicrobial therapy for patients with severe sepsis and septic shock -- a quality improvement study. *PLoS One* 2014;9:e104475.
19. Sterling SA, Miller WR, Pryor J, Puskarich MA, Jones AE. The impact of timing of antibiotics on outcomes in severe sepsis and septic shock: a systematic review and meta-analysis. *Crit Care Med* 2015;43:1970-1915.
20. Ferrer R, Martin-Loeches I, Phillips G, et al. Empiric antibiotic treatment reduces mortality in severe sepsis and septic shock from the first hour: results from a guideline-based performance improvement program. *Crit Care Med* 2014;42:1749-1755.
21. Labelle A, Juang P, Reichley R, et al. The determinants of hospital mortality among patients with septic shock receiving appropriate initial antibiotic treatment. *Crit Care Med* 2012;40:2016-2021.
22. Puskarich MA, Trzeciak S, Shapiro NI, et al. Association between timing of antibiotic administration and mortality from septic shock in patients treated with a quantitative resuscitation protocol. *Crit Care Med* 2011;39:2066-2071.
23. Kumar A, Zarychanski R, Light B, et al. Early combination antibiotic therapy yields improved survival compared with monotherapy in septic shock: a propensity-matched analysis. *Crit Care Med* 2010;38:1773-1785.
24. Keir I, Dickinson AE. The role of antimicrobiais in the treatment of sepsis and critical illness-related bacterial infections: examination of the evidence. *J Vet Emerg Crit Care* 2015;25:55-62.
25. Waechter J, Kumar A, Lapinsky SE, et al. Interaction between fluids and vasoactive agents on mortality in septic shock: a multicenter, observational study. *Crit Care Med* 2014;42:2158-2168.
26. Fujishima S, Gando S, Saitoh D, et al. A multicenter, prospective evaluation of quality of care and mortality in Japan based on the Surviving Sepsis Campaign guidelines. *J infect Chemother* 2014;20:115-120.
27. Frasca D, Dahyot-Fizelier C, Mimoz O. Prevention of central venous catheter-related infection in the intensive care unit. *Crit Care* 2010;14:212.
28. Angus DC, Barnato AE, Bell D, et al. A systematic review and meta-analysis of early goal-directed therapy for septic shock: the ARISE, ProCESS and ProMISe investigators. *Intensive Care Med* 2015;41:1549-1560.
29. Zhang L, Zhu G, Han L, Fu P. Early goal-directed therapy in the management of severe sepsis or septic shock in adults: a meta-analysis of randomized controlled trials. *BMC Med* 2015;13:71.