Meta-analysis of PiCCO monitoring and guiding the use of vasoactive drugs in the treatment of septic shock patients

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Abstract. As a clinical monitoring method, PiCCO has been widely used in the monitoring of patients with septic shock in recent years. However, it has not been concluded whether PiCCO has more clinical advantages than traditional central venous pressure monitoring. In this paper, 868 literatures were collected through meta-analysis, and 3 literatures meeting the inclusion criteria were screened according to the exclusion criteria set in advance, and a total of 5 studies were obtained. Statistical analysis is conducted by Revman5.4 software provided by Cochrane, and the conclusion is as follows: PiCCO monitoring technology can significantly reduce the use of vascular active drugs for patients with purulent septic shock, among which norepinephrin Z=9.09 (P <0.00001), dopamine Z = 4.92 (P <0.00001). Therefore, we recommend using Picco technology clinically.

Keywords: Pulse indicating continuous cardiac output monitoring (PiCCO); Septic shock; Systematic review; Meta-analysis; Randomized controlled trial

1. Introduction

The American Society of Critical Care Medicine (SCCM) and the European Society of Intensive Care Medicine (ESICM) jointly issued the 3.0 definition and diagnostic criteria for sepsis in 2016, defining it as a life-threatening organ dysfunction caused by the body's maladjusted response to infection [1]. Septic shock as one form of sepsis, refers to the even after given enough liquid recovery is still unable to correct the sustainability of low blood pressure, is a circular function disorder symptoms, it is often the direct cause of death in critically ill patients, with a clinical mortality rate of more than 40%. Active and effective fluid resuscitation is the key to treatment, but too much or too little fluid may affect the effectiveness of resuscitation [2-3]. Pulse Indicator Continuous Cardiac Output (PiCCO) measuring technology can monitor patients with multiple blood flow dynamic indicators for liquid recovery guidance. It is a new technique combining pulse contour continuous cardiac output with transpulmonary temperature dilution cardiac output, which can accurately and continuously monitor the changes of cardiac output, hemodynamics, extravascular lung water (EVLW) and other indicators[4]. However, it has not been determined whether PiCCO has a clinical advantage over traditional central venous pressure (CVP) monitoring techniques for the management of septic shock. To this end, we adopted a meta-analysis method to analyze the dose of vasoactive drugs used in PiCCO guiding the treatment of septic shock patients, in order to provide a theoretical basis for its clinical application.

2. Materials and methods

2.1. Search strategy

Keywords to choose PiCCO, pulse indicator continuous cardiac output, endotoxic shock, septic shock, RTC, randomized controlled trial, etc. The time limit for retrieval was March 26, 2022, the retrieval databases are CNKI, VIP database, Wanfang database, PubMed, Web of Science, Cochrane Library, EBSCO.
2.2. Inclusion and exclusion criteria

2.2.1 Inclusion criteria

The type of study was RCT (randomized controlled study) of septic shock monitored by PiCCO. The diagnostic criteria of septic shock were the guidelines for the treatment of sepsis and septic shock in China. The treatment group (interference group) was treated with PiCCO, while the control group was treated with traditional CVP monitoring technology or other technologies (non-PICCO technology such as traditional liquid monitoring technology). The outcome indicator is: total dose of vasoactive drugs (including medication duration and patient weight data).

2.2.2 exclusion criteria

Non-Chinese and English literature; Duplicate published results; Incorrect or incomplete data and failed to contact the corresponding author; Retrospective analysis of studies; Review and meta-analysis studies; The object of the study is not a PiCCO directed septic shock treatment study; Secondary analysis based on research done by others; It's an RCT study but the sample are not human.

2.3. Literature screening and data extraction

The two researchers independently conduct literature screening according to the criteria, data extraction and cross-check. In the case of lack of information, try to contact the original author as much as possible. The main contents of extraction include: ① Basic information incorporated into the research includes the first author of the subject, publication time, etc; ② Research design types and key factors of bias risk evaluation; ③ Basic features of the interference group and control group; ④ Effect indicators and specific data of measurement results.

2.4. Assessing risk of bias in included studies

The Revman 5.4 software of Cochrane was used for evaluation. The co-assessed risks included bias risk inclusion (high risk, low risk, and unclear risk). This work was conducted by two investigators.

2.5. Statistical analysis

Fixed effect model was selected when the Revman 5.4 software test results were non-heterogeneous; random effect model was selected if heterogeneity existed. The measurement data were $\bar{x} \pm s$, 95%CI was used to represent the effect size, and $P < 0.05$ was considered statistically significant.

3. Results

3.1. Literature screening process and results

A total of 868 related literatures were obtained through literature retrieval, and 3 literatures were included after screening strictly according to inclusion criteria and exclusion criteria, including 5 studies. The specific process is shown in Figure 1.
Figure 1. Literature screening process and results

3.2. Features of the literature

Table 1. Basic characteristics of the studies included

| Studies       | Sample size (Intervention/Control) | Age (Intervention/Control, year) | Intervention | Control | Total vascular active drugs |
|---------------|-----------------------------------|----------------------------------|--------------|---------|-----------------------------|
| Xia et al.[5] | 38/38                             | 65.2±4.3/65.9±7.9                | PiCCO monitoring | routine monitoring | norepinephrine dosage |
| 201 (1)       |                                   |                                  |              |         |                            |
| Xia et al.[5] | 38/38                             | 65.2±4.3/65.9±7.9                | PiCCO monitoring | routine monitoring | Dopamine dosage |
| 201 (2)       |                                   |                                  |              |         |                            |
| Wang et al.[6] | 30/30                            | 24.5±4.6/56.1±5.7                | PiCCO monitoring | Traditional liquid monitoring | norepinephrine dosage |
| 201 (1)       |                                   |                                  |              |         |                            |
| Huang et al.[7] | 43/43                           | 63.5±8.2/63.9±9.0                | PiCCO monitoring | Traditional liquid monitoring | norepinephrine dosage |
| 201 (1)       |                                   |                                  |              |         |                            |
| Huang et al.[7] | 43/43                           | 63.5±8.2/63.9±9.0                | PiCCO monitoring | Traditional liquid monitoring | Dopamine dosage |
| 201 (2)       |                                   |                                  |              |         |                            |

After rigorous literature screening, 3 literatures were included in this study, including 5 studies in total, among which 3 studies involved norepinephrine and 2 studies involved dopamine.

3.3. Risk bias evaluation of included studies

The risk bias of all included studies is shown in the figure.
In terms of the risk of bias, the study of Huang Qingsheng’s group had patient performance error (risk of bias) because it clearly informed patients of the details of the study.

### 3.4. Analysis of forest maps included in the study

The 5 studies we include will be grouped for discussion according to the different active drugs involved.

Figure 2 shows the active drug is norepinephrine and Figure 3 shows the active drug is dopamine.
Figure 4. Results of the meta-analysis when the active drug is dopamine.

Heterogeneity ($I^2$) in both groups is 0, indicating that our inclusion analysis had good reliability. Meanwhile, $Z=9.09$ ($P < 0.00001$) in the first analysis and $4.92$ ($P < 0.00001$) in the second analysis.

4. Conclusion

In our meta-analysis, it was found that the amount of vasoactive drugs decreased significantly when PiCCO technology was used as monitoring method (norepinephrine $Z=9.09$; dopamine $Z=4.92$). In addition, among the included studies, only the study of Huang Qingsheng’s group had certain research risks because it clearly informed patients of the specific study details, while the other risks were unknown or low risk. The possibility of other possible interference and objective sampling were not clearly informed in all other studies. Therefore, PiCCO technology, as a better monitoring method, has certain advantages in clinical application and has strong promotion value.

References

[1] Mervyn Singer, Clifford S. Deutschman, Christopher Warren Seymour, Manu Shankar-Hari, Djillali Annane, Michael Bauer, Rinaldo Bellomo, Gordon R. Bernard, Jean-Daniel Chiche, Craig M. Coopersmith, Richard S. Hotchkiss, Mitchell M. Levy, John C. Marshall, Greg S. Martin, Steven M. Opal, Gordon D. Rubenfeld, Tom van der Poll, Jean-Louis Vincent, Derek C. Angus. The Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3) [J]. JAMA, 2016, 315(8).

[2] Cai Xue, Qin Wei, Zhuang Wenwen. Comparison of intensive ultrasound and PiCCO monitoring in guiding fluid resuscitation in septic shock [J]. Shenzhen Journal of Integrated Traditional Chinese and Western Medicine, 2018, 28(04): 10-12. DOI: 10.16458/j.cnki.1007-0893.2018.04.005.

[3] Liu Yalin, Zou Shuai, Zhao Zhonglin, Wang Xiaorui, Zhang Ting, Chen Yanran. Value of PiCCO monitoring technique in guiding use of fluid resuscitation and vasoactive drugs for patients with septic shock [J]. Chinese Journal of Nosocomiology, 2016, 26(10): 2254-2256.

[4] Zou Hong, Chen Keyu, Zou Yan, Wang Xiaoping, Zhang Chunyan, Wang Fang. Application of PiCCO and bedside ultrasound in treatment of patients with septic shock [J/OL]. Chinese Journal of Nosocomiology, 2022(05): 698-702[2022-04-06]. http://kns.cnki.net/kcms/detail/11.3456.R.20220314.1004.028.html

[5] Xia BJ, Shi SY. Application effect of pulse index continuous cardiac output monitoring in the fluid management of infectious shock patients complicated with acute respiratory distress syndrome [J]. Practical Journal of Cardiac Cerebral Pneumal and Vascular Disease, 2016, 24 (5) : 100 – 102.

[6] Wang Jinli, Chen Jieming, Muen. Analysis of improvement function of fluid management and prognosis in patients with septic shock complicated with acute respiratory distress syndrome by PiCCO technology [J]. Journal of Clinical Emergency (China), 2019, 20(09): 737-740. DOI: 10.13201/j.issn.1009-5918.2019.09.016.

[7] Huang Qingsheng, Li Yan, Fang Xinxing, Guo Jianying, Zhang Huwei, Wang Zhigang, Zhang Lixia. Application of pulse indicator continuous cardiac output in patients with septic shock complicated with acute respiratory distress syndrome [J]. Chinese Journal of Nosocomiology, 2017, 27(19): 4371-4374.