Assessment of Acute Failure of Continuous Veno-venous Hemodiafiltration in Surgery Based on Computer Information Analysis Technique

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Abstract. Objective: to investigate the application of continuous veno-venous hemodiafiltration (CVVHDF) in acute renal failure (ARF) after cardiac surgery. Methods: 30 patients with acute renal failure after cardiac surgery in xijing hospital from June 2011 to December 2013 were selected and treated with CVVHDF. The changes of Cr, BUN, electrolyte (K+, Na+, Cl-, etc.), HR, MAP, PaO2/FiO2, CVP were compared at 24 and 72 h before and after treatment using computer data analysis technology. Results: of the 30 patients, 26 survived and 4 died. Among them, the urine volume and renal function of the surviving patients returned to normal. Compared with before treatment, Cr, BUN, electrolyte (K+, Na+, Cl-, etc.) and HR were all significantly reduced, with statistically significant differences (P <0.05). The oxygenation index (PaO2/FiO2) and average arterial pressure (MAP) were significantly increased, while the central venous pressure (CVP) was significantly reduced, with statistically significant differences (P <0.05). Conclusion: CVVHDF is a safe and effective treatment and is worthy of clinical application.

Keywords: Continuous Venovenous Hemodiafiltration, Acute Renal Failure, Cardiac Surgery, Computer Information Analysis

1. Introduction

Acute renal failure (ARF) can cause severe complications to the circulatory system and other systems if not treated in time [1]. The increase of volume load is prone to inducing acute heart failure, which is also one of the most common causes of ARF leading to death. Currently, dialysis and filtration treatment have been extensively performed in major cardiac surgery centers in China to address severe ARF after surgery, and its efficacy has also been verified through a large number of clinical trials. However, due to the limitations of clinical research and hospital conditions at all levels, it is still challenging to develop a unified plan for dialysis and filtration treatment of severe ARF after surgery. The clinical mortality is still high, and the prognosis of patients with ARF is not ideal [2-3]. The overall mortality varies from 50% to 70%. The mortality of patients with renal and renal dialysis is 63.7. The mortality of patients requiring dialysis was 53. Therefore, how to deal with the ARF after cardiopulmonary bypass is still of great significance [4]. In this study, we selected ARF patients who...
received continuous blood purification (CBP) and the corresponding patients receiving peritoneum dialysis (PD) at random to study the application of CBP and PD after cardiopulmonary bypass in cardiac surgery, to explore the best time for clinical application and treatment effect and further analyze its effect on the body [5-6].

ARF is a severe complication after cardiac surgery. It is mainly manifested in the increase of serum creatinine (CR) and urea nitrogen (BUN), the disorder of water, electrolyte, acid-base balance and oliguria, which may endanger the life of patients. Hence, early treatment should be found. Continuous venovenous hemodiafiltration (CVVHDF) is a kind of renal replacement therapy, especially for patients with multiple organ failure and ARF. It has the advantages of stable hemodynamics, high nutrition in vein, elimination of various inflammatory media, control of water, electrolyte, acid-base balance, etc. In this paper, the clinical effect of CVVHDF in ARF after cardiac surgery is discussed, with the report as follows.

2. Data and methods

2.1. General information

Thirty patients with ARF after cardiac surgery in Xijing Hospital from June 2011 to December 2013 were selected, including 22 males and 8 females, aged from 30 to 78 years, with an average age of (41.23 ± 14.46). Among them, 7 patients were classified as grade II, 15 as grade III, and 8 as grade IV according to their cardiac function; 4 patients receiving cardiac surgery, 6 receiving coronary stenting, 12 receiving valve replacement, 6 receiving aortic bypass replacement, 1 receiving balloon dilatation, and 1 receiving aortic dissection; 21 patients had normal blood creatinine (CR), urea nitrogen (BUN) and urine volume before operation, and the other 9 patients presented symptoms of renal insufficiency before surgery. The study showed that that the higher the Apache score after ARF, the poorer the effect of CBP treatment, the worse the prognosis; while the lower the score, the better the treatment effect, the higher the survival rate. A Korean study also suggested that the higher the APACHE III score, the higher the risk of death.

2.2. Methods

After 12 h of open-heart surgery, blood creatinine (CR) was 220-860 μmol/L, average 379 μmol/L, urea nitrogen (BUN) was 22-50mmol/L, average 36mmol/L. Before the treatment with CVVHDF, 30 patients received medical intervention based on the diagnosis standard of ARF, but the effect was not good, urine volume continued to decrease, 24 h later, they were treated with CVVHDF. Before treatment, the patients were assessed and treated with anticoagulation. The patients chose to establish vascular access with a single needle and double-lumen indwelling catheter in the femoral vein under B-ultrasound and treated with AN69 blood filter and M60 pipeline. The blood flow of the blood pump was set at 100 ml/min, and the velocity of the replacement solution was set to 2-3 L/h. The post-dilution method was adopted. The ultrafiltration capacity was adjusted according to the volume of fluid replacement and capacity load. The ultrafiltration capacity was 8900 ml after 24 h of dialysis filtration. During dialysis, blood coagulation was observed at all times, and small doses of coagulant were administered continuously. Systolic blood pressure was maintained above 90mmHg, the first 4:

\[
\Phi(t) = \Phi(T_0) + f(t - T_0) + \sum_{i=1}^{n} \frac{f^{(i)}(t - T_0)}{(i+1)!}
\]

Where \( t \) represents hospital benefit information; \( \Phi(T_0) \) represents efficacy assessment, \( T_0 \) represents the information of time; \( f \) represents the frequency of the patient information; \( f^{(i)} \) represents the \( i \) derivative of \( f \) (generally \( i = 1, 2, 3 \)).

To simplify the efficacy assessment, \( i = 2 \) is taken, and the following can be obtained
\[ \Phi(t) = \Phi(T_0) + f(t - T_0) + \sum_{i=1}^{n} \frac{f^{(i)}(t - T_0)}{(i+1)!} \]  

(2)

Where \( f, \dot{f}, \ddot{f} \) and \( \Phi(T_0) \) represent the model parameters, i.e., the accuracy of patient information assessment, the first derivative, and the second derivative of accuracy, which can be obtained by fitting the long-term assessment data of information.

3. Results

3.1. Comparison of conditions before and after cvvh

Among the 30 patients, 26 survived, and 4 died. The urine volume and renal function of the surviving patients returned to normal. Compared with those before treatment, the serum creatinine (CR) decreased from 365.6 ± 167.3 μmol/L to 259 ± 112 μmol/L on the first day, to (179 ± 82) μmol/L on the second day, the urea nitrogen (BUN) decreased from (39 ± 14) mmol/L to (31 ± 12) mmol/L on the second day, and the electrolyte (K+, Na+, Cl-, etc.) and heart rate (HR) decreased significantly at 2 d. The difference was statistically significant (\( P < 0.05 \)). The mean arterial pressure (map) increased from 52-60 mmHg to 69-75 mmHg, the central venous pressure (CVP) decreased from 15-17 mmHg to 9-13 mmHg, and the difference was statistically significant (\( P < 0.05 \)). The results were shown in Table 1.

| Item                             | Before CVVH treatment | 24 h after CVVH treatment | 72 h after CVVH treatment | \( P \)  |
|----------------------------------|-----------------------|---------------------------|---------------------------|--------|
| Serum creatinine (CR) (μmol/L)  | 365.6±167.3           | 259±112                   | 179±82                    | 0.0413 |
| Urea nitrogen (BUN) (mmol/L)    | 39±14                 | 31±12                     | 21±11                     | 0.0324 |
| Heart rate (HR) (times/min)     | 120±9                 | 99±13                     | 90±8                      | 0.003  |
| Mean arterial pressure (map) (mmHg) | 64±8               | 73±6                      | 76±3                      | 0.001  |
| Central venous pressure (CVP) (mmHg) | 16.3±2.6           | 11.6±2.7                  | 9.4±2.8                   | 0.001  |
| Arterial oxygen partial pressure (PaO2) (mmHg) | 54±6               | 67±5                      | 80±9                      | 0.001  |
| Blood K+ (mmol/L)               | 5.7±6.9               | 5.3±4.3                   | 5.0±2.1                   | 0.001  |

3.2. Efficacy

When the renal function of patients with CVVHDF was basically restored to normal, two of them were randomized to discontinue the treatment of dialysis filtration, and the situation of oliguria and deterioration of renal function occurred again. After the treatment of dialysis filtration, the renal function and urine volume returned to normal. Although four patients died in the treatment, they were all patients with severe heart damage. Three of them had multiple organ failure. One patient had a severe infection after cardiac surgery. The renal function of the four patients improved at the beginning of dialysis filtration.

Table 2. Effect of CBP treatment on heart and kidney functions of ARF patients after cardiac surgery

| Item              | Before CBP treatment | 12 h | 24 h |
|-------------------|----------------------|------|------|
|                   | Survival Group | Death group | Survival Group | Death group | Survival Group | Death group | Survival Group | Death group |
| LVEF              | 0.42±0.06          | 0.68±0.05 | 0.44±0.08 | 0.39±0.07   | 0.47±0.05 | 0.42±0.06 |
| CO(L/min)         | 4.42±0.95          | 4.17±0.86 | 4.65±1.06 | 4.38±0.91   | 5.06±1.03 | 4.74±1.08 |
| CI(L/min*mm²)     | 2.41±0.58          | 2.12±0.55 | 2.51±0.65 | 2.27±0.50   | 2.78±0.59 | 2.40±0.62 |
| BUN(c/mmol • L⁻¹) | 19.56±5.47         | 25.63±8.32 | 16.24±4.86 | 21.30±4.35  | 14.35±6.21 | 17.65±7.32 |
| Cr(c/μmol • L⁻¹)  | 325.30±102.9       | 391.20±120.4 | 250.30±87.3 | 287.30±94.7 | 198.60±73.2 | 240.20±87.3 |
4. Conclusions

ARF is a syndrome of nitrogen waste retention and urine volume reduction caused by a sudden decrease in renal function in a short period. The main manifestations include the increase of Cr and bun, the disorder of water, electrolyte, acid-base balance, and oliguria, which can be life-threatening to the patients in severe cases. Blood purification technology is often adopted in the clinical treatment of ARF, which has a good effect and extensive application. Most patients receiving cardiac surgery are the elderly presenting multiple organ failure. The possibility of ARF is very high, and so is the mortality. The efficacy of blood purification technology is not very significant. In the treatment of multiple organ failure (MOF) and ARF, CVVHDF has the advantages of stable hemodynamics, high nutrition in the veins, elimination of various inflammatory mediators, control of water, electrolyte, acid-base balance, etc. Hence, where ARF complications are identified, CVVHDF treatment should be performed as early as possible, which is conducive to maintaining the cardiac circulation, reducing the cardiac burden, protecting the cardiac function, and improving the prognosis of patients. In this paper, 30 patients with ARF after cardiac surgery in Xijing Hospital from June 2011 to December 2013 were selected and treated with CVVHDF. In addition, the therapeutic effect was excellent, the safety was high, and the case fatality rate was significantly reduced. In conclusion, CVVHDF has an excellent effect on ARF after cardiac surgery, with the advantages of rapid, safe, and effective recovery of urine volume and renal functions, which is worthy of further clinical promotion and application.

References

[1] Rounis, E. , Laing, C. M. , & Davenport, A. . (2010). Acute neurological presentation due to copper deficiency in a hemodialysis patient following gastric bypass surgery. Clinical nephrology, 74(5), 389-392.
[2] Dungu, J. , O'Donnell, M. S. , Hawkins, P. N. , & Anderson, L. J. . (2012). 069 systematic review of 1142 admissions with acute heart failure reveals high frequency of transthyretin v122i cardiac amyloidosis in afro-caribbean patients. Heart (British Cardiac Society), 98(Suppl 1), 39-40.
[3] M. E. O’ Connor, Kirwan, C. J. , Pearse, R. M. , & Prowle, J. R. . (2015). Incidence and associations of acute kidney injury after major abdominal surgery. Intensive Care Medicine, 42(4), 521-530.
[4] Humes, H. D. , Sobota, J. T. , Ding, F. , Song, J. H. , & Group1, T. R. I. . (2011). A selective cytopheretic inhibitory device to treat the immunological dysregulation of acute and chronic renal failure. Blood Purification, 29(2), 183-190.
[5] Roncon-Albuquerque, R. , Beco, A. , Ferreira, A. L. , Gomes-Carvalho, C. , & Hafe, P. V. . (2010). Therapeutic implications of heparin-induced thrombocytopenia complicating acute hemodialysis. Clinical nephrology, 73(4), 326-330.
[6] Tadashi Omoto, Atsushi Aoki, Kazuto Maruta, & Tomoaki Masuda. (2016). Surgical outcome in hemodialysis patients with active-phase infective endocarditis. Annals of Thoracic & Cardiovascular Surgery Official Journal of the Association of Thoracic & Cardiovascular Surgeons of Asia, 22(3), 181.