Research Article

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The effects of gastrointestinal function on the incidence of ventilator-associated pneumonia in critically ill patients

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Abstract: Objective. To investigate the effect of gastrointestinal function on the incidence of ventilator-associated pneumonia (VAP) in critically ill patients. Methods. From August 2012 to June 2016, 160 critically ill patients in the ICU (Intensive Care Unit) of our hospital were selected as the research group; patients were divided equally into an observation group and a control group, 80 patients in each group, based on the random draw envelope principle. The control group was given a nasogastric tube for gastric feeding; the observation group was given a dual lumen gastrointestinal enteral device for gastric feeding; the two groups’ enteral nutrition observation time was 7d; any changes in patient condition and prognosis were recorded. Results. The pH value of gastric juice in the control group and the observation group was 6.13±1.38 and 4.01±1.83, respectively; the pH for the observation group was significantly lower than that of the control group (t=4.982, P<0.05). The incidence of VAP in the observation group and the control group was 2.5% and 12.5%, respectively; the VAP for the observation group was significantly lower than that of the control group (P<0.05). The serum levels of pre-albumin and albumin after feeding in the two groups were significantly higher than before feeding (P<0.05); the serum levels of pre-albumin and albumin in the observation group after feeding were significantly higher than those in the control group (P<0.05). The mechanical ventilation time and ICU length of stay in the observation group were 9.12±2.13 days and 12.76±1.98 days, respectively, significantly lower than those of the control group of 10.56±2.89 days and 16.33±2.11 days (P<0.05). Conclusion. Obstacles to gastrointestinal function in critically ill ICU patients are common; enteral gastric feeding by dual lumen gastrointestinal for can improve the patient’s nutritional status, promote and maintain the normal pH value of gastric juice, thereby reducing the incidence of VAP through rehabilitation of patients.

Keywords: Critically ill patients; Ventilator-associated pneumonia; Gastrointestinal function; Albumin; Gastric juice pH value

1 Introduction

Ventilator-associated pneumonia (VAP) is a pulmonary infection that occurs in patients with respiratory failure after primary mechanical ventilation for 48 hours (h) or extubation within 48h [1,2]. Some studies have shown that in critically ill ICU patients account for about 1/3 of the hospital infection rate; once VAP occurs it involves difficult weaning and a prolonged hospital stay, as well as a mortality rate over 10% [3,4]. In patients with critical illness, mechanical ventilation cannot be used for oral feeding to meet their nutritional and metabolic needs, and enteral nutrition intervention is needed [5]. In most critically ill patients, the body is in a state of high stress, mostly resulting from gastrointestinal dysfunction. This makes the patient prone to local microcirculatory disturbance of the gastric mucosa, which then requires increased nutritional support. Enteral nutrition can help patients undergoing mechanical ventilation treatment: it is a part of their treatment and is closely related to prevention and treatment of ventilator-associated pneumonia. However, which method of supplying enteral nutrition can better prevent the occurrence of ventilator-associated pneumonia has become the focus of ICU ward research. Studies have shown that nutritional adjustment can reduce the changes in metabolism such as high metab-
olism, high decomposition and other anomalies; it can also create favorable conditions for neuronal regeneration and repair and prevent recurrence [6,7]. Nasogastric tube enteral nutrition, therefore, increases the risk of reflux and aspiration of gastric contents and lowers prevention of VAP. Improving the patient's gastric motility may help reduce gastric reflux and bacterial colonization, thereby preventing VAP [8-10], but specific methods of improving gastric motility have not been reported. In this paper, the effect of different gastrointestinal functions on the occurrence of VAP in critically ill patients is discussed, and methods of improving gastric motility are proposed.

2 Data and methods

2.1 Object of study

From August 2012 to June 2016 in our hospital’s intensive care unit (ICU) mechanical ventilation in 160 critically ill patients were the research group; inclusion criteria were hemodynamic stability (heart rate, oxygen saturation greater than or equal to 90% 60-120 / min, mean arterial pressure, respiratory rate of <30 / 70-120 mmHg, intracranial pressure <20 mmHg); mechanical ventilation time above 4D; nutrition screening scale (NRS2002) score above 3 points; acute physiology and chronic health evaluation II (APACHE II) score above 15 points; patients having mechanical ventilation and enteral nutrition support treatment indications. Exclusion criteria: Patients with stress ulcer or digestive tract bleeding before observation; aspiration and pulmonary infection before mechanical ventilation; pregnant and lactating women; psychiatric patients. Based on the principle of random envelope drawing, the patients were divided into an observation group and a control group with 80 cases in each group. The sex, age, BMI, disease type, APACHE II score, and NRS2002 score of the two groups were not significantly different (P>0.05). Details are shown in Table 1.

2.2 Gastrointestinal feeding method

In the control group, a nasogastric feeding route was adopted. In the observation group, a gastrointestinal double lumen tube fed the intestinal tract (Figure 1).

Enteral Nutritional Suspension was chosen for parenteral nutrition (Nutricia Pharmaceutical Co. Ltd., bottle 500 mL, 1.5 kcal/mL), using enteral nutrition pump for continuous infusion, transfusion of 1000 mL/d, infusion rate for 50 mL/h. The observation group and the control group were given gastrointestinal feeding at the same time through the stomach tube route. When the residual amount of stomach was >250 mL, the patient underwent gastrointestinal drainage and decompression. During the implementation process, enteral nutrition was given at 6:00 every morning. The amount of infusion and the speed of infusion were adjusted based on the needs of the patients’ energy metabolism to ensure that the enteral nutrition was finished before 2:00 the next day.

The observation time of enteral nutrition support in the two groups was 7d.

2.3 Observation index

Determination of pH value of gastric juice: during the period of enteral nutrition, the gastric juice was taken every day, and the average value of pH value of 7D gastric juice was calculated.
juice was recorded. (2) Ventilator-associated pneumonia: judging by the diagnostic criteria of Chinese Medical Association Respiratory Disease Branch, and it will be determined at least 2 items appeared during mechanical ventilation, as followingVMA: arterial oxygen partial pressure decreased unexplained during mechanical ventilation, PaO2/FiO2 and >30.0% decreased; the body temperature rises to more than 38 deg C; chest X-ray showed new exudative lesions; endotracheal aspirates purulent secretions, and bacterial culture (+). (3) Nutritional index test: serum prealbumin (PA) and serum albumin (ALB) were detected before and after enteral nutrition support in all patients. (4) Prognosis: observe and record the two groups of mechanical ventilation time and ICU hospitalization time.

2.4 Statistical method

SPSS20.00 software was used for statistical data analysis, measurement data using standard deviation (x + s), t-test and paired t-test compared with the independent sample data, and count data expressed as a percentage, compared with the chi square analysis; P<0.05 represents a significant difference.

Ethical approval: The research related to human use has been complied with all the relevant national regulations, institutional policies and in accordance the tenets of the Helsinki Declaration, and has been approved by the authors’ institutional review board or equivalent committee.

Informed consent: Informed consent has been obtained from all individuals included in this study.

3 Results

3.1 Comparison of pH values in gastric juice

The gastric juice pH values of the control group and the observation group during enteral nutrition were 6.13 ± 1.38 and 4.01 ± 1.83 respectively; the value for the observation group was lower than that for the control group (t=4.982, P<0.05).

3.2 VAP incidence comparison

After observation, the incidence of VAP in the observation group and the control group during enteral nutrition was 2.5% and 12.5%, respectively; that for the observation group was significantly lower than that for the control group (P<0.05) (Table 2).

3.3 Comparison of nutritional indexes

After testing, the two groups after nutritional support of serum prealbumin and albumin values were signifi-

| Group          | Number of cases (n) | VAP | Incidence of VAP |
|----------------|---------------------|-----|------------------|
| Observation group | 80                  | 2   | 2.5%             |
| Control group   | 80                  | 10  | 12.5%            |

| X² | 3.878 |
|---|---|
| P  | <0.05 |
significantly higher than before nutritional support ($P<0.05$); we observed that the serum prealbumin and albumin values in the nutritional support group were significantly higher than those in the control group ($P<0.05$) (Table 3).

### 3.4 Comparison of mechanical ventilation time and ICU hospitalization time

After observation, the observation group’s mechanical ventilation time and ICU hospitalization time were $9.12 \pm 2.13d$ and $12.76 \pm 1.98d$, all significantly lower than the control group’s $10.56 \pm 2.89d$ and $16.33 \pm 2.11d$ ($P<0.05$). (Table 4).

### 3.5 Discussions

VAP is the most common infectious complication in critically ill patients: the incidence rate is as high as 10%, and the fatality rate is about 20%. For this reason, we mainly strengthened the preventive support intervention in our clinic [11]. At the same time, during mechanical ventilation of critically ill patients the metabolic needs of the body must be met to ensure the intake of drugs and nutrients; to promote physical rehabilitation, increased nutrition intervention is necessary [12].

Patients undergoing mechanical ventilation who are unable to ingest food orally can have a major clinical intervention through gastrointestinal nutrition, but that also increases the risk of reflux and aspiration of gastric contents. In critically ill patients, there is often a gastrointestinal motility disorder, and reflux and inhalation of gastric contents can also cause VAP [13,14]. The occurrence of VAP causes difficulty in weaning, prolongs hospitalization time, and affects the life of patients. Therefore, corresponding preventive measures should be taken to reduce gastric reflux, avoid inhalation of oropharyngeal secretions, regularly check whether the gastric tube is properly placed and observe the intestinal motility, adjust feeding volume and speed, and avoid reflux occurs of gastric contents. In the gastrointestinal double lumen tube feeding through the intestine, food enters the intestinal tract directly, avoids food going into the stomach, stimulates the gastric acid secretion process, achieving thereby a better acid-suppression effect. The present study showed that the pH value of gastric juice during enteral nutrition in the control group and the observation group was $6.13 \pm 1.38$ and $4.01 \pm 1.83$, respectively, and that in the observation group was significantly lower than that of the control group ($t=4.982$, $P<0.05$). At the same time, using a gastrointestinal double lumen tube by enteral feeding and gastrointestinal decompression residue monitor inside the stomach reduces the probability of gastric mucosal

| Group         | Number of cases (n) | Prealbumin (mg/L) Pre nutritional support | After nutritional support | t     | P   | Prealbumin (mg/L) After nutritional support | t     | P   |
|---------------|---------------------|-----------------------------------------|---------------------------|-------|-----|---------------------------------------------|-------|-----|
| Observation   | 80                  | 0.11±0.06                               | 0.16±0.08                 | 8.348 | <0.05 | 23.49±4.22                                 | 10.584| <0.05|
| Control       | 80                  | 0.11±0.09                               | 0.14±0.10                 | 5.113 | <0.05 | 23.19±5.29                                 | 5.184 | <0.05|
| t             |                     | 0.000                                   | 3.456                     |       | <0.05 | 0.453                                      | 5.295 | <0.05|
| P             |                     | >0.05                                   | <0.05                     |       |      |                                             |       |     |

| Group         | Number of cases (n) | Mechanical ventilation time | ICU hospitalization time |
|---------------|---------------------|-----------------------------|--------------------------|
| Observation   | 80                  | 9.12±2.13                   | 12.76±1.98               |
| Control       | 80                  | 10.56±2.89                  | 16.33±2.11               |
| t             |                     | 3.224                       | 4.891                    |
| P             |                     | <0.05                       | <0.05                    |
VAP is caused by gastric or oropharyngeal secretions with trace contamination of pathogenic bacteria in the lower respiratory tract; this can cause aspiration with reflux and bacterial growth opportunities, reduce the incidence of VAP; and its intermittent acid induced transient increase, avoid regurgitation of gastric contents into the respiratory tract and reduce the risk of VAP [18,19].

Patients with mechanical ventilation are prone to gastrointestinal disorders due to positive airway pressure, because the air shortage caused by swallowing reflex hyperfunction can also cause regurgitation and aspiration, cause or worsen lung infection, upon prolonged mechanical ventilation [20]. Dual lumen gastrointestinal feeding helps to maintain the pH value of gastric juice in the normal range, helping to inhibit the growth of digestive tract bacteria [21]; it can meet the nutritional needs of patients with a short period of time, can avoid the excessive expansion of the stomach to reflux. This study shows that two groups of nutritional support after the serum prealbumin and albumin values were significantly higher than before nutritional support (P<0.05), and we observed that the nutritional support group of serum prealbumin and albumin values were significantly higher than those in control group (P<0.05). That also shows that the dual lumen gastrointestinal after enteral feeding can improve the body’s nutritional status. Most of the patients with mechanical ventilation are critically ill, and the operation of the endotracheal intubation puts the body in a highly stressed state. Improving the gastrointestinal function of critically ill patients can help reduce the rate of gastric reflux and lung infection [22-23]. This study shows that the mechanical ventilation time and ICU hospitalization time were 9.12 ± 2.13d and 12.76 ± 1.98d, are significantly lower than the control group of 10.56 ± 2.89d and 16.33 ± 2.11d (P<0.05), also improve the gastrointestinal motility of patients can promote the rehabilitation of patients.

In short avoiding some obstacles to gastrointestinal function in critically ill ICU patients, gastrointestinal double lumen tube enteral feeding can improve the patient’s nutritional status, promote and maintain the normal pH value of gastric juice, thereby reducing the incidence of VAP and assist the patient’s rehabilitation.

Declaration of conflict of interest: The authors declare that there are no conflicts of interest.

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