The problem of ventilation arrest in the use of portable type respirators

Takashi Nishimura, M.E., Yumi Sato, R.M., Katsunori Tatara, M.D.

Department of Medical Risk Management Office, Tokushima National Hospital, National Hospital Organization, 1354 Shikiji, Kamojima, Yoshinogawa, Tokushima 776-8585 Japan

Received 4 January 2011; received in revised form 15 January 2011; accepted March 14 2011

Abstract

There were 22 ventilation arrest cases in incident reports in the Tokushima Hospital over nine years. The ventilation arrests occurred with all models used at the hospital, and were not limited to a specific model. The main causes were the deterioration of the parts (27.3%) due to age, and initial defectiveness of the programs (18.2%).

Five ventilation arrests occurred with a change of the power supply (22.7%). Fortunately, no ventilation arrest has led to a medical error in our hospital. When the patients undergoing artificial respiration during hospitalization leave their sickbed, or when the patients undergo artificial respiration at home, it is necessary to change the power supply. Ventilation arrests with respirators are not rare. It is always important that the precise and prompt processing is taken with ventilation arrests.

Keywords: respirator, ventilation arrest, neuromuscular diseases, risk management

Introduction

The Tokushima Hospital has specialized in treating muscular dystrophy and intractable neurologic diseases ever since it was a national sanatorium. Patients suffering from these neuromuscular diseases often require long-term artificial respiration. Artificial respiration therapy greatly contributes to improvement of the vital prognosis and the quality of life of the patients. As a result, the number of hospitalized patients with neuromuscular diseases who receive long-term management of artificial respiration has increased rapidly. In particular, respirators are attached to 60% of inpatients with muscular dystrophy. [1] More than 90 portable type respirators always operate in Tokushima National Hospital. Furthermore, there are 60 patients who use attached respirators. The safe management of the apparatus used for these chronic artificial respiration cases is a serious duty of the medical safety management room.

Correspondence to: Takashi Nishimura, M.E, T Tokushima National Hospital, National Hospital Organization, 1354 Shikiji, Kamojima, Yoshinogawa, Tokushima 776-8585 Japan Phone: +81-883-24-2161 Fax : +81-883-24-8661

We analyzed the ventilation arrest cases which might be connected directly with serious medical errors.

Materials & Methods

In Tokushima National Hospital, respirator-related incident reports have been reported with an original format in our medical safety management room for ten years. [2] The information is examined by a clinical engineer and the head of medical safety management. The number of reports was 849 by the end of 2009.

Results

As for the ventilation arrest, 23 cases (2.7%) were reported in total. One case was excluded because of insufficient data, and the remaining 22 were examined. The number of occurrences every year is shown in Figure 1. Seven models of respirator caused a ventilation arrest. These were: Achieva, seven cases; BiPAP HarmonyS/T, one case; Companion 2801, eight cases; LegendAir, one case; LTV950, two cases; O'NYXplus, one case; PLV100, two cases. Arrests were proved to occur with all models used in our hospital. For all ventilation arrests, appropriate processing was taken. Therefore, the patients' effect levels were 2 or less with all cases. The situation is shown in Table 1. There were two cases which occurred at home. Ventilation arrest was caused once when an inpatient stayed out in the home, and once when an outpatient stayed out in the home. Sixteen cases occurred when the patients were awake. Eleven cases occurred when the patients were using an electric wheelchair which carried a respirator. There were 15 cases when a hospital staff member discovered a ventilation arrest, three cases when a family member discovered the arrest, and three cases when patients noticed the problem. At the time of ventilation arrest, there was some kind of alarm (such as a sound) in 20 cases. However, the presence or absence of an alarm could not be confirmed in two cases. These two cases both occurred at home (an at-home artificial respiration case, a staying out case), and the reporter was a family member. Three cases in total were caused by human error. There were cases which were caused by the wrong battery voltage, and cases where the breaker was touched by mistake. The causes of ventilation arrest were classified, and are shown in table 2. There were three problems with deterioration due to secular variation. One case was reported with each of three models, (Achieva, O'NYXplus, LTV950). A case which occurred in 2009 was caused by the deterioration due to age of the condenser. It was recognized that a similar problem occurred in the nationwide muscular dystrophy study by Kamino (2010). Because all problems were caused by the condenser deterioration of the power supply, the manufacturer made repairs voluntarily in March 2010. There were three kinds of machines in which ventilation arrest occurred due to motor damage by bearing abrasion (Achieva, BiPAP Harmony, LegendAir). With the LegendAir model, there was a case of turbine motor damage. Damage to the ball bearing of the crank arm occurred in the Achieva model. In addition, a periodic inspection was conducted based on the recommendations of the maker's

manual in both apparatuses. A ventilation arrest due to a leak was found in three cases in the Achieva model. The model was programmed to stop ventilation to prevent instrumental overload when the quantity of supply of air exceeded 1,800 ml. When it was used in pressure control mode for non-invasive positive pressure artificial respiration, a ventilation arrest was caused. This trouble was resolved by resetting. The program was revised by the suppliers based on the report from our hospital, and these issues subsequently disappeared. However, four years were needed for the problem to be solved from the initial problem development. Ventilation arrest caused by a breaker operating occurred in two cases with two models (Companion2801, PLV100). There were two cases when an external battery caused a problem (Companion2801, Achieva). A ventilation arrest occurred due to a battery of the wrong voltage being used. There were nine unidentifiable cases of ventilation arrest. Of these, five cases occurred when power was switched from an external battery to AC power.

Figure 1. Number of ventilation arrests every year

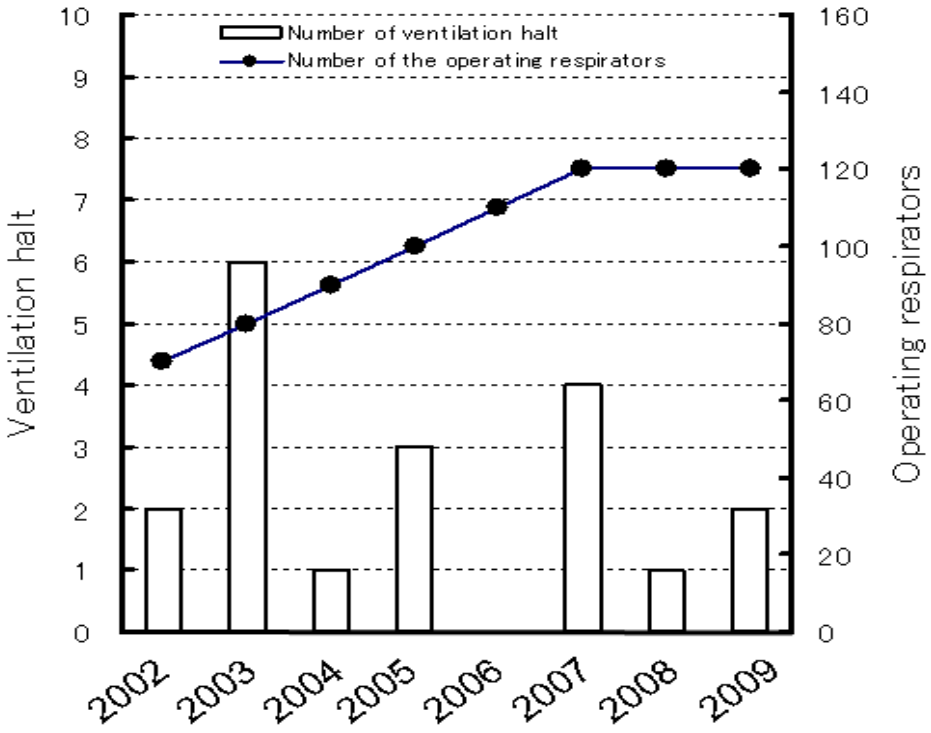

Table 1. The situation of the ventilation halt

Nidus of accident		Number	%
In a sickroom		18	81.8
Outside a sickroom	In a hospital	1	4.5
	Outside a hospital	3	13.6
Total		22	100

Consciousness state			
awakening	In a sickbed	5	22.7
	Outside a sickbed	11	50
sleep		6	27.3
Total		22	100

Table 2. Cause of the ventilation halt

	Number	%
Aged deterioration of the part	6	27.3
Initial defectiveness of the respiratory program	4	18.2
Human error	3	13.6
Unidentified		
At a power supply change	5	22.7
Besides a power supply change	4	18.3

Discussion

In national hospital regional institutions, it was clear as of December, 2005 that approximately 2,300 patients with neuromuscular diseases receiving chronic artificial respiration were hospitalized [1]. For this large number of chronic artificial respiration cases, the national hospital mechanism sets a standard model [3]. Each hospital has a serious interest in safety management and analyzes the incident report information to develop accident prevention measures. Among artificial respiration-related problems, ventilation arrest has a high risk of leading to a serious accident. We analyzed incident report information from Tokushima National Hospital over nine years. As a result, ventilation arrest cases were proved to be very common. Therefore, measures assuming a ventilation arrest may develop are necessary. Having a reserve bag valve mask is a minimum measure. The training of medical support staff who deal with ventilation arrests should be conducted repeatedly. When a problem occurs it is important to discover the cause as soon as possible,

and to take measures. In the muscular dystrophy study of Shinno (2010), 27 hospitals built a network system to share information, and to solve problems early, in cooperation with medical equipment makers. It is important that these systems spread to hospitals over the whole country. The causes of ventilation arrest have been classified into categories. The first is deterioration due to ageing of parts, particularly in the portable type of respirator, which is often used continually, and in the long term. There is a possibility that the deterioration of the instrument parts due to continuous use is more serious than is usually believed. There is a report [4] that utilization time correlates with ventilation arrest. The second cause is initial defectiveness, such as programs. The modern respirator is controlled with a computer. Malfunction of the program may become clear for the first time in clinical settings without being recognizable in the development. Because the built-in battery was proved to be defective, leading to some cases of ventilation arrest with the LegendAir, the defective battery was repaired voluntarily by the company. For the chronic artificial respiration patients, aiming at quality of life improvement is demanded. We want our findings to be considered as a serious alarm bell to those who practice artificial respiration routinely.

References

1. Tatara K, Ishikawa Y, Imai T, Ichihara N, Shinno S, Nishima S. Survey on long-term ventilator-assisted individuals in Japanese National Hospital Organization (third report) (in Japanese) J Jpn Soc for Resp Care Reha 2009;19:151-155.

2. Tatara M. Risk management of the respirator treatment in neuromuscular disorders. The establishment of the risk management system for the muscular dystrophy from the situation of the physician. (in Japanese) Iryo 2002;56:260-265.

3. Tatara K, Ishikawa Y, Ichihara N, Kawahara H, Imai T, Shinno S, Nishima S. Fukunaga H. Survey of patients with neuromuscular disorders requiring long-term ventilator-assistance in hospitals of the Japanese National Hospital organization: a trial for the standardization of the ventilator (in Japanese) Iryo 2010;64:257-264.

4. Blanch PB. An evaluation of ventilator reliability: A multivariate, failure time analysis of common ventilator brands. Respir Care 2001;46:789-797.