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Research Article

The Effect of PDCA Circulation on Improving The Up-to-Standard Rate of Wearing Time Length in OSAHS Patients with Non-Invasive Ventilator

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Abstract

Purpose: To investigate the clinical effect of PDCA（Plan-Do-Check-Act） circulation mode in patients with obstructive sleep apnea hypopnea syndrome (OSAHS) using continuous positive air way pressure (CPAP) ventilator. **Methods:** 83 patients with OSAHS who were treated in the department of otorhinolaryngology head and neck surgery were randomly divided into PDCA group (n = 41) and control group (n = 42). The nursing outcomes of the two groups were compared. **Result:** The rate of reaching the standard wearing time length of non-invasive ventilator in the PDCA group was 80.49%, which was significantly higher than that in the control group (35.71%), and the difference was statistically significant (χ^2=17.005, P<0.05). The compliance rate of patients in the PDCA group (90.24%) was higher than that in the control group (73.80%), and the difference was statistically significant (Z= 2.571, P<0.05). The incidence of adverse reactions in the PDCA group was 19.51% lower than that in the control group (64.29%), and the difference was statistically significant (χ^2=17.005, P<0.05). The score of fatigue in the PDCA group (4.17 ±1.223) was significantly lower than that in the control group (6.45 ±0.803). **Conclusion:** PDCA circulation nursing model can effectively improve the up-to-standard rate of time length of patients wearing non-invasive ventilator, reduce the incidence of adverse reactions, improve patient compliance and reduce patient fatigue, which is worthy of clinical promotion.

Key words: PDCA circulation nursing model; the up-to-standard rate of time length of non-invasive ventilator; compliance; incidence of adverse reactions; fatigue degree.

Introduction

Obstructive sleep apnea hypopnea syndrome (OSAHS) is a sleep-related respiratory disorder characterized by recurrent partial or complete collapse of the upper respiratory tract during sleep, causing intermittent hypoxia, increased inspiratory work and sleep interruption (1-2), New research

shows that more than 10% of adults may suffer from OSAHS (3). Continuous positive airway pressure (Continuous Positive Airway Pressure, CPAP) is the first choice for the treatment of moderate to severe OSAHS. The principle is to send continuous positive airway pressure into the airway through a mask and open the upper airway while the patient is sleeping (4), to improve nocturnal apnea, snoring, suffocation and reduce the incidence of daytime sleepiness in patients with OSAHS, but the compliance is usually not optimistic. When compliance was defined as more than 4 hours of nocturnal use, 46%-83% of OSAHS patients reported non-compliance with treatment (5). PDCA cycle is a timely management model, which was originally conceived by Shewhart and later expanded into a quality control cycle by Dr. Deming in the United States, including P (plan), D (do), C (check) and A (action) (6), PDCA-based nursing management model is a new nursing model that combines PDCA circulation with nursing management, which aims to improve nursing quality and clinical effect (7). In this study, PDCA circulation was applied to non-invasive mechanical ventilation in patients with OSAHS to improve the rate of reaching standard time length of wearing non-invasive ventilator.

Materials and methods

1. General information

Eighty-three patients with OSAHS treated in our department from April 2022 to September 2022 were randomly divided into control group (n = 42) and PDCA group (n = 41). Control group include 27 males and 15 females with the age of 30-68 (48.31±11.76), while PDCA group include 25 males and 16 females, aged 32-68 (48.80±9.58). Inclusion criteria: (1) 18 years old or older; (2) patients with moderate or severe OSAHS diagnosed in accordance with the diagnostic criteria of obstructive sleep apnea hypopnea syndrome (revised version) in 2011; (3)sleep apnea hypopnea disorder index (AHI)≥15 times/hour; (4)Education level above junior high school; (5) clear consciousness and no communication barrier. Exclusion criteria: (1) patients with heart or lung diseases; (2) patients receiving treatment that may affect sleep, such as sedation, muscle relaxants, etc.; (3) patients with simple or mild OSAHS; (4) patients allergic to ventilator mask; (5) patients who are unwilling to sign informed consent. All the patients knew and understood the rules of this trial, and there was no significant difference in the general data between the two groups ($P > 0.05$).

2. Method

The OSAHS patients in the control group were treated with routine methods, including explaining the function and purpose of CPAP ventilator and matters needing attention during wearing, such as breathing with closed mouth, relaxing breathing regularly, checking closeness to avoid air leakage, and thoroughly checking the performance of ventilator (power supply, ventilation mode, humidifier, parameters and alarm value setting, etc.) before use. At the beginning, patient lay down with a comfortable position, connect the ventilator pipe, adjust the appropriate parameters, adjust the position of the nose mask, the tightness of the headband should be as loose as inserting into 1 or 2 fingers, and record the highest pressure per hour in the middle and night shift. during the inspection of the ward, the sleep status of the patients and the normal working of the instrument were observed. The PDCA group additionally applied the PDCA cycle management mode beside the treatment of the control group, and the specific methods were as follows:

2.1 Plan（P）

2.1.1 Set up a PDCA management team.

Determine the members of the quality control team, headed by the head nurse, and those with seniority of more than three years as team members. Through reviewing the literature and consulting experts, we jointly worked out the data collection table, compliance collection table, fatigue scale,

examination table, complications questionnaire, etc., and the department quality control team also needed to investigate the knowledge of all the nursing staff about CPAP ventilator, such as the structure of ventilator, the selection of mask, pressure titration, etc. , and then the team leader trained the team members on the theory of PDCA circulation and the wearing standard of CPAP ventilator. There are also homogenization training of data collection table, compliance collection table, fatigue scale and check table collection method.

2.1.2 Investigation of current situation

Through the collection of data and scales, the up to standard rate of non-invasive ventilator wearing time length in the control group from April to June 2022 was 35.71%. According to the 80/20 principle, the influence factor of the cumulative percentage of 74.07% is the focus of improvement, and it is determined that "low patient compliance" and "occurrence of adverse reactions" are the main factors leading to the poor up to standard rate of non-invasive ventilator wearing time.

2.1.3 Main factor analysis and target setting

According to the examination table and complications questionnaire, the existing problems were summarized and analyzed, including the following reasons: nurse factors: non-standard pressure setting, inadequate headband adjustment, lack of psychological care, no detection of air leakage; patient factors: dry nasopharynx, oppression, holding breath, man-machine confrontation, eye discomfort caused by ventilator leakage, nasal and facial skin tenderness. Through Pareto Chart, it is concluded that the focus of improvement is 74.07%, and the group ability is scored as 84% by all the team members. The target value is obtained by application of the formula for calculating the target value of nursing improvement project: Target value = current value + improvement value = current value + (1-current value) × group capacity × improvement focus) = 35.71% + (0.6429×0.7407×0.84)×100% =75.71%.

2.2 Do(D)

2.2.1 Diversified propaganda and education to improve patient compliance. As the compliance of patients is poor, the key point of nursing work is to introduce the importance and basic working principle of CPAP ventilator treatment to patients. The quality control team worked out popular science promotional films as well as self-media rolling broadcast to achieve better publicity results, as well as unified and standardized publicity brochures and regular distribution, and through the establishment of CPAP treatment adaptation area, the ventilator will be well understood, and operated by encouraged patients themselves, so that OSAHS patients will accept CPAP ventilator in their mind , and dispel doubts about CPAP treatment ,improve compliance.

2.2.2 Precise training to improve the personal skills of nursing staff. The department adopts the strategy of parallel training and assessment, formulates the training plan according to the actual situation of the personnel, adopts the way of group training, and divides the nurses into several groups. Under the guidance of the group leader, through typical case learning plus role-playing, simulate the wearing process of CPAP therapy, and self-evaluation and reflection, while observing the wearing of other groups, to explore and correct the existing problems. After the training, the head nurse randomly assessed the theoretical knowledge in the form of questionnaire stars at the morning and regular meetings to improve the professional skills of nurses.

2.2.3 Establish a cycle of pre-and post-intervention. Through accurate pressure titration for the first time in advance, psychological intervention, prevention of complications, and post-evaluation of the status of patients, to reduce the fear caused by holding breath and other undesirable discomfort of patients. Meanwhile, nurses should communicate with patients actively,

listen to patients, grasp patients' psychological changes in time, actively guide patients, to establish the best mental state, and establish confidence in treatment. For the adverse reactions that may occur during treatment, such as dry nasopharynx, sense of pressure, holding breath, man-machine confrontation, eye discomfort caused by ventilator leakage, nasal and facial skin tenderness, etc., nurses should choose a soft nasal mask with appropriate size to prevent air leakage, and guide patients with dry upper respiratory tract to use humidifier to increase humidity in the channel and help patients adjust appropriate ventilator pressure level. Reduce the occurrence of adverse reactions.

2.2.4 Take improvement measures such as life and diet care. Correct unhealthy behavior and living habits, arrange diet structure, quit smoking and drinking, regular activities, form good habits, actively communicate with patients' families, and obtain their trust and support, and provide a good atmosphere for patients. For patients with BMI≥24, body composition analysis and measurement were carried out, the reported results were analyzed, and a health management program was established in cooperation with the nutrition department, combined with diet or drug weight loss.

2.3 Check（C）

The head nurse supervises and checks the implementation effect, organizes regular meetings for discussion and analysis, and the quality control team corrects the problems existing in the improvement process in time, and determines whether the target value is reached after statistical analysis.

2.4 Act（A）

Continuously improve the up to standard rate of OSAHS patients wearing time length of non-invasive ventilator, draw up a new PDCA management plan for existing problems, and apply PDCA model to other quality control management projects in the department.

3. Index and judgment criterion

3.1 The up-to-standard rate of non-invasive ventilator wearing time length in OSAHS patients.

The up-to-standard rate of non-invasive ventilator wearing time length in OSAHS patients was defined as the proportion of up to standard times of non-invasive ventilator wearing time length to the total up to standard times in the statistical cycle of OSAHS patients.

3.2 Compliance of OSAHS patients with non-invasive ventilator

Compliance refers to the degree to which patients comply with the treatment plan, expressed by the compliance index (CI), as a parameter to judge compliance. In this study, the ratio of OSAHS patients' actual use of non-invasive ventilator to each doctor's order was taken as the compliance of OSAHS patients wearing non-invasive ventilator. The greater the CI, the better the compliance. The compliance was good when CI > 85%, 85%-60% moderate, and poor when CI < 60% (8).

3.3 Incidence of adverse reactions to non-invasive ventilator in patients with OSAHS

Adverse reactions include holding breath, feeling of pressure, dry nasopharynx, man-machine confrontation, eye discomfort caused by ventilator leakage, nasal and facial skin tenderness and so on.

3.4 Fatigue degree of patients with OSAHS

In this study, the visual analog fatigue scale was used to investigate the fatigue score of OSAHS patients before and after CPAP treatment. The Visual Analog fatigue scale (Visual Analogue Fatigue Scale, VAS-F) is a single-dimensional fatigue assessment tool that marks the line segment of the scale 10cm. The fatigue intensity is calculated in terms of the value of the scale from the starting point, with the starting end indicating no fatigue at all and the other end indicating

complete fatigue. The higher the score, the stronger the degree of fatigue (9).

4. Statistics

The data were analyzed by SPSS22.0. The data were expressed as $\bar{x}\pm s$ deviation, with t-test, counting data as rate (%), with χ^2 test, and grade data were compared with two independent samples Wilcoxon rank sum test. $P < 0.05$ indicates that the difference is statistically significant.

Result

1. PDCA circulation significantly improve the up-to-standard rate of non-invasive ventilator wearing time length.

The up-to-standard rate of non-invasive ventilator wearing time length in OSAHS patients in the PDCA group was significantly higher than that in the control group ($P < 0.05$) (Table 1).

2. PDCA circulation significantly improve the compliance of non-invasive ventilator therapy.

The compliance of the PDCA group was significantly higher than that of the control group, and the difference was statistically significant ($P < 0.05$) (Table 2).

3. PDCA circulation significantly reduce the degree of fatigue of non-invasive ventilator therapy.

The degree of fatigue in the PDCA group was lower than that in the control group, and the difference was statistically significant ($P < 0.05$) (Table 3).

4. Comparison of the incidence of adverse reactions between the two groups of OSAHS patients after intervention.

The incidence of adverse reactions in the PDCA group was significantly lower than that in the control group ($P < 0.05$).In the control group, the incidence of Holding breath was 14.29%, Sense of pressure 21.43%, Dry nasopharynx 11.90%, man-machine confrontation 7.14%, others (eye discomfort caused by ventilator leakage, skin tenderness 9.52%). The total incidence of adverse reactions was 64.29%, while in the observation group, the incidence of Holding breath was 9.76%, Sense of pressure was 4.88%, the Dry nasopharynx was 2.44%, the man-machine confrontation was 2.44%, and the others (eye discomfort caused by ventilator leakage and skin tenderness was 0%). The total incidence of adverse reactions was 19.51%, as shown in Table 4.

Table 1. comparison of up-to-standard rate of non-invasive ventilator wearing time length between the two groups.

Groups	Cases	Up to standard number（%）
Control	42	15（35.71）
PDCA	41	33（80.49）
χ^2		17.005
P		0.000

Table 2 . comparison of compliance between the two groups.

Groups	Case	Compliance			
		Good	Moderate	Poor	Total compliance rate（%）
Control	42	25	6	11	73.8

PDCA	41	35	2	4	90.24
Z					2.571
P					0.010

Table 3. comparison of fatigue degree between the two groups.

Groups	Cases	Fatigue degree
Control	42	6.45±0.803
PDCA	41	4.17±1.223
t		10.074
P		0.00

Table 4. comparison of the incidence of adverse reactions between two groups.

Groups	Cases	Adverse reactions					Total incidence of adverse reactions (n/%)
		Holding breath	Sense of pressure	Dry nasopharynx	Man-machine confrontation	Others	
Control	42	6	9	5	3	4	27/64.29
PDCA	41	4	2	1	1	0	8/19.51
χ^2							17.055
P							0.000

Discussion

1. PDCA increased the up to standard rate of non-invasive ventilator wearing time length in OSAHS patients, improved the compliance, reduced the adverse reactions and alleviated their fatigue degree.

PDCA model is now widely used in nursing management. Continuous discovery and improvement of treatments can effectively improve the clinical efficacy and nursing management ability. In this study, PDCA circulation method was used to implement timely and effective countermeasures for patients with different adverse reactions. for example, the key to prevent air leakage is to choose a nasal mask of appropriate size and appropriate tightness of the headband, while many patients mistakenly believe that the tighter the headband is, the less likely it is to have air leakage. Nurses need to inform in advance that there is a good elasticity of the cushion of the nasal mask, if it is loosened properly, no leakage is supposed to happen, to reduce the incidence of air leakage. Accurate pressure setting can prevent patients from holding their breath and discomfort caused by man-machine confrontation, which makes patients pull off their masks themselves. once patients reflect Holding breath and maladjustment, nurses should adjust appropriate pressure values to help patients fall asleep again. The reason for the dryness of the nasopharynx caused by long open mouth breathing is that the pressure of the ventilator is not enough to completely overcome the obstruction of the upper airway, so it is necessary to increase the pressure of the ventilator. Another way is to increase airway humidity through drinking water and humidifier to reduce nasopharynx dryness. The result showed that

through the intervention of PDCA circulation mode, the up-to-standard rate was improved, reached the target, The incidence of adverse reactions in patients decreased significantly, and the compliance of CPAP treatment in the PDCA group was significantly higher than that in the control group, which indicated that PDCA mode could significantly improve the compliance of CPAP treatment, and the degree of fatigue in the PDCA group was significantly improved after intervention, indicating that the application of PDCA mode could improve the therapeutic effect of OSAHS patients wearing CPAP ventilator. Targeted nursing and omni-directional health education increased patients' understanding of the disease and satisfaction with treatment and nursing, promote trust, improved nurse-patient relationship, improved compliance, reduced fatigue, and alleviated OSAHS symptoms.

2. Improve the professional ability of nurses.

PDCA circulation mode improved the cooperation ability of nursing team, promoted specialized nursing ability and management ability of nurses, and slowly improved their knowledge mastery and effective use during regular examination and supervision examination, which can comprehensively solve patients' questions and enhance the spirit of caution and independence.

3. Beneficial to hospital management

The PDCA cycle model can be gradually extended to other departments of the hospital to help the common progress of the quality control and management, and continuous innovation is beneficial to the coordinated development of the hospital.

The PDCA circulation can effectively improve the up-to-standard rate of non-invasive ventilator wearing time length of OSAHS patients during the procedure of treatment, which is better than routine nursing and is worth popularizing.

Declarations

1) ***Consent to publication***
We declare that all authors agreed to publish the manuscript at this journal based on the signed Copyright Transfer Agreement and followed publication ethics.
2) ***Ethical approval and consent to participants***
This case has ethical approval and patient consent.
3) ***Disclosure of conflict of interests***
We declare that no conflict of interest exists.
4) ***Funding***
None
5) ***Availability of data and material***
We declare that the data supporting the results reported in the article are available in the published article.
6) ***Acknowledgement***
None.
7) ***Authors 'contribution***
Authors contributed to this paper with the case management (YR, LW, JY), writing (LW), revision (YR, LW, JY), editing (YR, LW, JY) and final approval (YR).
8) ***Authors' biography***
None

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