The Effectiveness of Immediate Non-invasive Positive Pressure Ventilation on Decreasing the Re-intubation Rate of Unplanned Extubation

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Abstract

Unplanned extubation, or UE is a common event occurring in the ICU. UE will lead to many serious complications that may extend the duration of stay in the ICU and possibly patient mortality. The historical control study aimed to understand whether re-intubation rate in ICU patients with UE would decrease when given treatment from non-invasive positive pressure ventilation (NIPPV). 24 months retrospective collection of data from October 2006 to September 2008. 114 adult ICU patients, aged 18 years or older and qualified for use of intubation ventilation for more than 48 hours and with UE incidences, are designated as control group. From October 2008 to December of 2009, 62 cases were collected prospectively from 4 adult intensive care units, who developed UE and were given NIPPV immediately for over 8 hours. These cases were designated as the sample group. There were 40 patients from the sample group that did not require re-intubation (64.5%), and 54 patients in control group (47.4%). Statistical analysis revealed that the p value between the two groups was 0.029, showing that immediate administering NIPPV can significantly reduce the re-intubation rate needed for UE. Re-intubation may lead to secondary injury and increase incidence rates of clinical complications and mortality in patients with unplanned extubation. The immediate provision of NIPPV may be an effective measure to decrease the re-intubation needed for patients. (J Intern Med Taiwan 2012; 23: 351-359)

Key Words: Unplanned extubation, NIPPV

Introduction

Placement of an endotracheal tube is a common medical procedure in use by the intensive care units (ICU), as patients suffering from respiratory failure will require endotracheal intubation to rely on external ventilators for treatment. When treatment has been completed, the endotracheal

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tube is removed via planned extubation procedures. Unplanned extubation, or UE, is the unscheduled removal of the endotracheal tube due to various factors that may have arisen during the removal procedure. UE is a common intensive care unit accident; previous literatures and clinical studies have indicated that incidence rate occurs from 2.8% to 20.6%[1,2]. Unplanned extubation may lead to many complications; injury and edema of the trachea from tube extraction may lead to serious conditions such hypoxia and respiratory failure. Re-intubation may also lead to further damages to the trachea and aspiration pneumonia, extending the stay needed in the ICU and increasing patient mortality rates[3,4]. Therefore, it is imperative that for patient with UE an accurate assessment of the most appropriate medical procedure be made available to reduce the rate of re-intubation. Studies have shown that non-invasive positive pressure ventilation (NIPPV) offered a significant advantage for patients with high risk of extubation induced respiratory failure; however, few have investigated the beneficial effects of NIPPV on unplanned extubation[12.13.14]. This historical controlled study is the first study to focus on NIPPV and unplanned extubation. The study aimed to investigate whether NIPPV provided significant benefits for ICU patients with unplanned extubation, and whether this procedure will reduce re-intubation rate, clinical complications, patient mortality and unwarranted waste of medical resources.

Study Design and Purpose

Source of Case Data

This study was a historical controlled study. Data was retrospectively collected from a certain medical center in Central Taiwan over a 24-month period, from October, 2006 to September, 2008. Patients aged 18 years and above from four adult intensive care units (115 beds total; 2 for internal medicine and 2 surgical), and qualified for intubation over 48 hours with episodes of unplanned extubation were designated as the control group.

In addition, prospective case data collection from these four intensive care units was also performed from October, 2008 to December, 2009, in which patients with UE were immediately given NIPPV, as by doctor's orders for at least 8 hours, were designated as the sample group. Case exclusion criteria included non-cooperative patients and those with an immediate need for re-intubation.

After assessment of the need for re-intubation after UE, the control group was further divided into re-intubation group and non-intubation group. Non-intubation was defined as no re-intubation within 72 hours after the UE occurred; if there is intubation during the 72 hours, then it is categorized into the re-intubation group. Statistical analysis was performed to compare the clinical parameters the two groups in order to delineate the possible factors leading to necessity of re-intubation for patients.

For the sample case group, NIPPV was immediately given by the clinical respiratory therapist as per doctor's order. The ventilation aid was delivered via breathing mask for at least 8 hours. The parameters for the NIPPV were set up for maximum patient comfort, maintaining respiration rate, breathing type and pulse oximetry within reasonable clinical range. Cases were followed for successful extubation to determine whether regular, immediate use of NIPPV for UE patients has resulted in decreasing rate of re-intubation (Figure 1).

Indications of Re-intubation

Re-intubation is administered as deemed necessary by a clinical physician when a patient develops the following clinical symptoms of respiratory failure: alteration in consciousness, over 50% of oxygen concentration in use but the pulse oximetry indicated less than 90%, clear and continuous use of accessory respiratory muscles, ineffective clearance of airway secretions, severe

arrhythmia (ventricular tachycardia) or over 30 minutes of less than 90mmHg systolic pressure even when enough fluids and vassopressors have been given[3].

Data Collection

Basic characteristics of patients were recorded to perform correlation analysis and prediction on the possible factors of influence. Data collected included gender, age, departments, state of consciousness, setting modes of breathing apparatus (full assist mode, partial assist mode), days of intubation, days using ventilators, days in ICU, patient mortality and re-intubation rates.

Statistical Analysis

Data collected from the study were analyzed using the SPSS 10 Statistical Software, English Version (SPSS, version 10.0 for Windows; SPSS Inc; Chicago, IL), for data archiving and analysis. Results of the descriptive statistics analysis were presented as mean ± standard deviation and the number of cases (percentage), and were analyzed with the independent samples *t*-test, chi-square test or Fisher's exact test. A *p*-value less than 0.05 indicated statistically significance.

Instruments

The NIPPV used in this study were the Bi PAP, Respironics or VPAP III ST-A, BROJAW.

Results

Basic Information of Subjects

From October 2006 to September 2008, 114 control cases were collected from 6,279 patients with invasive ventilation. 113 sample cases were collected from 3,940 patients with invasive ventilation. 51 cases were excluded (Figure 1). The total collected was 2.22 % of all patients with invasive ventilation. The mean ages for both groups were 68±15 years for the control and 69±15 years for the sample group. The basic properties of the study samples and ventilator parameters are listed in table 1. Independent *t*-test and chi-square analysis or Fisher's Exact test were performed on the data from both groups to test for the homogeneity of the related information in both groups. The results showed that *p* values for age, gender, comorbidities, the cause of respiratory failure, ventilator mode and days of intubation were larger than 0.05, indicating that there was no statistical significance between

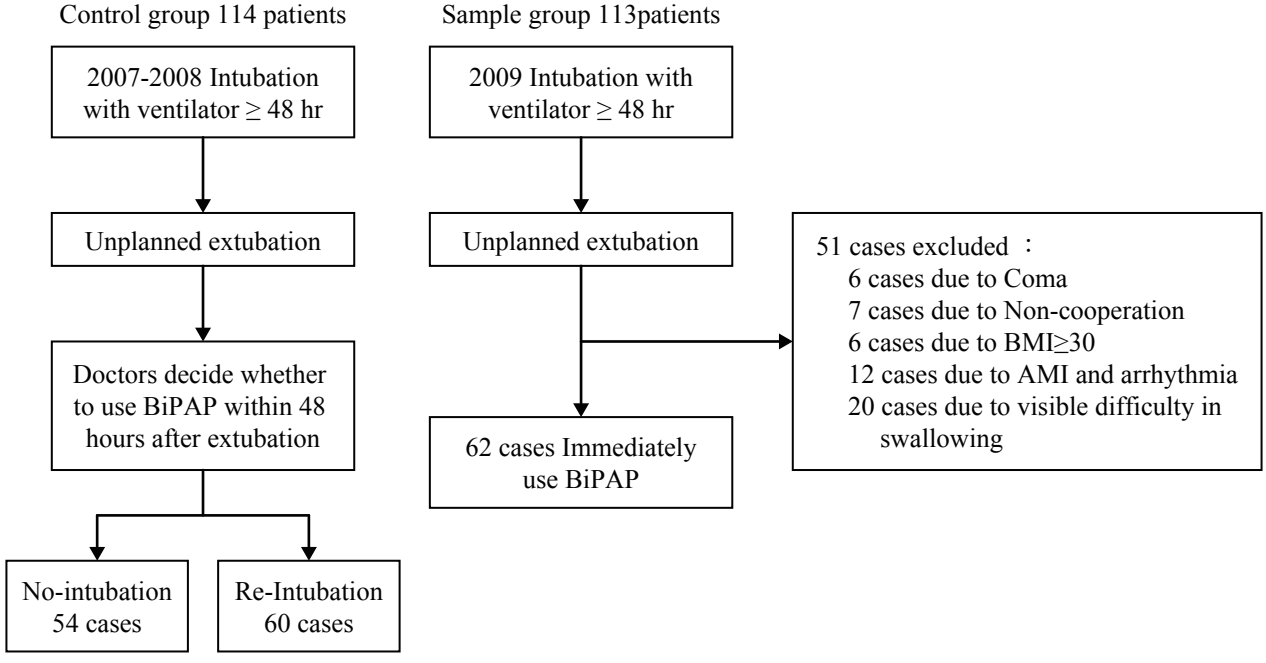

Figure 1. Schematic of Case Collection.

both groups. (Table 1).

Data Analysis between the Re-intubation and No-intubation Cases in the Control Group

114 cases from the control group were further categorized into Re-intubation and No-intubation, based on whether the case requires re-intubation within 72 hours after the UE occurred. 54 patients of the 114 cases did not require re-intubation (47.37%), while 60 cases (52.63%) required intubation. Analysis of the data between the two groups is shown in Table 2. Results have shown that there were no significant differences data such as gender, age, ventilation mode, days of intubation and time/shift of UE between the two groups within control group. However, comparison on the APACHEII scoring (acute physiological

Table 1. Basic Patient Characteristics, Ventilation Mode Settings and Homogeneity Analysis

	Control group (n=114)	Sample group (n=62)	P value
Gender			0.084
Male (cases, %)	76(66.7)	49(79)	
Female (cases, %)	38(33.3)	13(21)	
Age (years)	68±15	69±15	0.576
APACHEII	18±7	19±7	0.569
Ventilation mode			0.430
Partial assist mode (cases, %)	84(73.7)	49(79)	
Full assist mode (cases, %)	30(26.3)	13(21)	
Oxygen concentration (%)	33±15	35±12	0.751
Days of intubation (days) (days from intubation to extubation)	6±5	6±5	0.682
Comorbidities			0.542
Heart disease	29(25.4)	16(25.8)	
Pulmonary disease	12(10.5)	7(11.3)	
Liver disease	9(7.9)	8(12.9)	
CKD	5(0.9)	1(1.6)	
ESRD	13(11.4)	2(3.2)	
DM	13(11.4)	8(12.9)	
Cancer	12(10.5)	5(8)	
Nil	21(18.4)	15(24.2)	
Major cause of acute respiratory failure (cases, %)			0.312
Sepsis	68(60)	34(55)	
Major surgery	3(2.6)	5(8)	
ACS or CHF	5(3.5)	6(9.6)	
Acute stroke	13(11.4)	3(4.8)	
Trauma	20(17.5)	11(17.7)	
Massive GI bleeding	4(3.5)	2(3.2)	
Toxication	1(1)	1(1.7)	

Note: 1. Analysis of the basic patient characteristics and ventilation mode settings between the control and sample groups.
2. Statistical significance is denoted by a p value less than 0.05.
3. Nil: no comorbidity; CKD: chronic kidney disease; ESRD: End-Stage Renal Disease; ACS: acute coronary syndrome; CHF: congestive heart failure.

and chronic health evaluation system II) yielded 16±6 for the no-intubation and 20±8 for the re-intubation, indicating a statistically significant difference between the 2 groups ($p = 0.021$, <0.05). For immediate treatment after UE within the control group, 36 patients (66.7%) did not require re-intubation and were treated with normal oxygen within 48 hours after UE; 18 patients (33.3%) received at least 8 hours of mask assisted NIPPV, as evaluated by the clinical physician, within 48 hours after UE. For the Re-intubation group, 47 patients (78.3%) were treated with normal oxygen, 13 patients (21.7%) used NIPPV. The p value was 0.162, indicating no statistical significance between the two groups. (Table 2).

Comparison between Clinical Treatment Outcomes

The clinical treatment outcomes between the Re-intubation and No-intubation groups (within 72 hours after onset of UE) in the ICU were analyzed. The results showed that the mean days on a ventilator for the No-intubation group were 8±5 days, while the Re-intubation group was 18±13 days. Analysis of the ventilator removal rate and ICU mortality has shown that 51 patients in the No-intubation group experienced ventilator removal (rate 94.4%), and 2 died (mortality 3.7%); 32 patients in the Re-intubation group experienced ventilator removal (53.3%), and 22 died (mortality 36.7%), indicating significant differences in clinical

Table 2. Data analysis on the intubation and no-intubation groups within the control group

	No-re-intubation (n=54)	Re-intubation (n=60)	P value
Gender			
Male (cases, %)	36(66.7)	40(66.7)	1.000
Female (cases, %)	18(33.3)	20(33.3)	
Age (years)	69±15	67±16	0.526
APACHEII	16±6	20±8	0.021*
Days of intubation (days) (from intubation to extubation)	6±5	7±6	0.647
Intubation Shift:			0.331
Dayshift (cases, %)	22(40.7)	27(45.0)	
Night shift (cases, %)	19(35.2)	25(41.7)	
Late night shift (cases, %)	13(24.1)	8(13.3)	
Ventilation mode at extubation:			0.073
Full assist mode(cases, %)	10(17.9)	20(33.3)	
Partial assist mode(cases, %)	44(82.1)	40(66.7)	
Extubation procedures:			0.162
Oxygen masks (cases, %)	36(66.7)	47(78.3)	
BiPAP administered within 48 hours (cases, %)	18(33.3)	13(21.7)	
Days using ventilator (days)	8±5	18±13	0.001**
ICU ventilator removal rate (cases, %)	51(94.4)	32(53.3)	0.001**
ICU mortality rate (cases, %)	2(3.7)	22(36.7)	0.001**

Note: 1. Comparison analysis on the basic patient characteristics, the clinical procedures and ventilation mode setting, and clinical results (days using ventilator, ICU ventilator removal rate and ICU mortality rate) between the no-intubation and re-intubation cases in the control group
2. Statistical significance is denoted by a p value less than 0.05
3. ** p value less than 0.001

outcomes between cases requiring re-intubation and no-intubation (*p* value less than 0.001). (Table 2).

Whether Regular Provision of Immediate NIPPV Will Reduce Rate of Re-intubation

Our analysis has shown that there existed significant differences (Please see Table 3) on re-intubation rate and ventilator removal rate between the control group and the sample group (immediate use of NIPPV after unplanned extubation for at least 8 hours). In the control group, 60 cases (52.6%) required re-intubation within 72 hours after UE, while those in the sample group numbered 22 (35.5%); *p* value was 0.029. For the ICU ventilator removal rate, 83 cases in the control had their ventilators successfully removed (72.8%), while 55 cases in the sample group (88.7%) had successful ventilator removal; *p* value was less than 0.05. As for days of ventilation, there were significant differences between the two groups (*p* less than 0.05). However, there were no significant differences between the sample and the control group on ICU mortality, hospitalized ventilation removal rate and hospitalized mortality rate (see Table 3 and 4).

Discussion

The current study collected a total of 114 cases for the control group, 60 (52.6%) needed re-intubation; 47 of the cases needed re-intubation within 24 hours (78.3% of all patients who needed re-intubation). Of the 62 sample cases, 22 (35.5%) needed re-intubation, 11 of which required within

Table 3. Analysis of clinical ICU treatment outcomes between the control and sample groups

	Control group (n=114)	Sample group (n=62)	P value
Results of Unplanned extubation			0.029*
No need for re-intubation (cases, %)	54(47.4)	40(64.5)	
Re-intubation needed (cases, %)	60(52.6)	22(35.5)	
ICU ventilator removal rate (cases, %)	83(72.8)	55(88.7)	0.014*
ICU mortality rate (cases, %)	24(21.1)	6(9.6)	0.055

Note: 1. Comparison analysis on the clinical ICU outcomes (UE, ICU ventilator removal rate and mortality rate) between the Control and Sample groups.
2. * p less than 0.05 denotes a statistical significance.

Table 4. Analysis on the use of hospital ventilator between the control group and the sample groups

	Control group (n=114)	Sample group (n=62)	P value
Days using hospital ventilator:			0.017*
≤ 21 days (cases, %)	84(73.7)	55(88.7)	
22-63 days (cases, %)	28(24.6)	5(8.1)	
≥ 63days (cases, %)	2(1.7)	2(3.2)	
Results of using hospital ventilator			0.183
Removal of ventilator (cases, %)	83(73.6)	52(83.9)	
Deaths (cases, %)	24(20.2)	8(12.9)	
Use ventilator for more than 63 days (cases, %)	2(1.8)	2(3.2)	
Hospital transfer (cases, %)	5(4.4)		

Note: 1. Comparison analysis on the use of hospital ventilator between the Control and Sample groups.
2. * p value less than 0.05 denotes a statistical significance.

24 hours (50% of all cases who needed intubation). The sample group not only had significantly lower re-intubation rate than the control group, it was also lower than the 40-70% rate as reported previously [5,6]. Results from studies in different populations of disease groups have shown that NIPPV may effectively reduce the failure rate of extubation in patients with ventilators[8-11].

Unplanned extubation (UE) includes cases such as accidental and self-removal of the endotracheal tube by patients and is a common event seen in the ICU. Studies have shown that UE often occurs from factors such as unclear consciousness and agitation in patients, inadequate shifts of nursing staff and delayed extubation. The rate of UE in internal ICU is about 8.6%, 3% in surgical ICU, and the total incident rate is about 8-16%[5-7]. The total incident rate from this study was about 4-5%, slightly lower than the results from other studies, which may due to monitoring and improvement efforts of the nursing units in the aforementioned medical center.

Re-intubation is the procedure needed to re-establish breathing aid for patients with UE; however, complications such as airway damage and aspiration pneumonia may occur during the re-intubation process, further increasing the severity of the disease and difficulty of future ventilation removal. The worst may be increased mortality rate. The current study collected a total of 114 cases for the control group, 60 (52.6%) needed re-intubation. Of the 62 sample cases, 22 (35.5%) needed re-intubation. The sample group not only had significantly lower re-intubation rate than the control group, it was also lower than the 40-70% rate as reported previously[5,6]. Studies have shown that when UE occurred, a high percentage of patients required immediate re-intubation. However, secondary damages and mortality rates of patients may be decreased if proper procedures were followed and administered at the time of accidents.

Results from studies in different populations of disease groups have shown that NIPPV may effectively reduce the failure rate of extubation in patients with ventilators[8-11]. Nava S. et al., has reported that NIPPV may reduce the re-intubation rate of planned extubation[12]. Study by Agarwal R. et al., also recommended that the early provision of NIPPV may reduce re-intubation rate after the onset of UE, rather than waiting until respiratory failure develops[13,14]. Therefore, the current study, aside from analyzing the clinical differences between the re-intubation and no-intubation patients in control group for factors influencing the clinical outcomes, regular and immediate provision of NIPPV was given to the sample group to prove whether NIPPV can effectively decrease rate of re-intubation.

Our results have demonstrated that, aside from the APACHEII score having statistical significance between the re-intubation and no-intubation patients in the control group (score for no-intubation was16$\pm$6 and 20$\pm$8 for re-intubation, $p < 0.05$), there were no significant differences on gender, age, ventilation mode, days of intubation and time shift of extubation between the two groups of patients. The severity of the patient's disease status seemed to be the main factor influencing the decision for re-intubation.

For treatment after extubation in control group, 36 cases (66.7%) did not require re-intubation and only received oxygenation within 48 hours after extubation. 18 cases (33.3%) were evaluated by physicians to receive NIPPV for more than 8 hours, within 48 hours after extubation. For those that require re-intubation, 47 cases (78.3%) received only oxygenation treatment, while 13 cases (21.7%) received NIPPV. Comparison between the two group did not yielded statistically significant results (p value = 0.162) (Table2). Our results suggested that use of NIPPV within 48 hours after extubation did not effectively decrease rate of re-intubation. The result may be due to our delayed NIPPV

delivery to patients before respiratory failure occurs, therefore for the sample groups, the respiratory therapists were ordered to provide immediate NIPPV to patients with UE. Breathing aid was given through masks for at least 8 hours. Our results have shown that in the sample group, cases without re-intubation were 40 (64.5%), compared to the 54 cases in the control group (47.4%), with a p value of 0.029, indicating that immediate delivery of NIPPV may effectively reduce the rate of re-intubation after unplanned extubation occurred (Table3).

Limits and Suggestions

The main limits of this study were the difference in case collection for the control and sample groups and the unequal timing of case collection. In addition, the sample group had exclude 51 patients due to exclude criteria (Figure 1), but the retrospectively collected control cases had not been excluded. This bias may affect the fairness between the two groups. It is suggested that future studies may improve upon this area of study design. Also, the study results may be more persuasive if the case numbers for the sample group can be increased.

Conclusion

Re-intubation may lead to secondary damage to patients with unplanned extubation and increase the likelihood of clinical complications and mortality. Aside from improving clinical prevention on unplanned extubation, accurate assessments and treatments after the events have occurred, such as performing re-intubation when necessary or utilize procedures to reduce rate of re–intubation, are important items that must be taken into consideration to improve the quality of patient's artificial airway care. The immediate delivery of non-invasive positive pressure ventilation (NIPPV) may be an effective procedure to reduce the rate of re-intubation in patients.

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立即性非侵襲性正壓呼吸器的使用降低非計畫性拔管重插管率

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摘 要

非計畫性拔管(unplanned extubation, UE)是加護病房常見意外，非計畫性拔管所帶來的併發症，使患者延長加護病房住院天數，甚至增加死亡率。本研究期望了解加護病房患者在非計畫性拔管後，立即性使用非侵襲性正壓呼吸器是否能降低重插管。此回溯性對照研究收集2006年10月至2008年9月爲期24個月，成人加護病房年齡大於18歲，符合插管使用呼吸器超過48小時發生非計畫性拔管患者114人，定義爲控制組。另於2008年10月至2009年12月，在四個成人加護病房前瞻性收案，當患者發生非計畫性拔管後，依醫囑立即給予非侵襲性正壓呼吸器(NIPPV)，使用至少8小時，共收集62人，定義爲實驗組。結果顯示實驗組不需重插管的患者有40人(64.5%)，控制組54人(47.4%)，兩組間的P 值爲0.029，顯示立即性給予NIPPV能有效降低非計劃性拔管之重插管率。重插管造成非計劃性拔管病患之二次傷害，增加臨床合併症及死亡率。而立即性給予非侵襲性正壓呼吸器(NIPPV)，或許是降低病患重插管率之有效處置之一。