

Study on an Unplanned Extubation Prevention Program (UEPP) for Intubated Patients in Intensive Care Unit

Kyung-Ja, Kang*, Mi, Yu**

College of Nursing, Jeju National University*,

Department of Nursing, Namseoul University**

비계획적 발관 예방을 위한 교육프로그램 적용효과

강경자*, 유미**

제주대학교 간호학과*, 남서울대학교 간호학과**

Abstract Unplanned extubation prevention program (UEPP) was developed and applied to intubated patients hospitalized in a medical intensive care unit (ICU). The number of unplanned extubation was 29 during the preliminary investigation and 23 cases during the prevention intervention program. The general features of the patients and nurses who experienced UE did not have any significant differences between the two periods, with only the number of new nurses in the ICU being significantly different ($p=.039$). Although the number of new nursing staff in the ICU was high, the mean rate of unplanned extubation, which is the number of UE days per 1000 intubation days, was 8.8 during the prevention intervention program, which was significantly lower than 12.3, the mean rate of UE during the preliminary investigation ($t=-2.333$, $p=.040$). The results provide a prevention program that could contribute to the safety of patients by actively preventing unplanned extubation in intubated patients in ICU.

Key Words : Unplanned Extubation, Prevention, Program, Nurses, ICU

요 약 본 연구는 내과계 중환자실에 입원한 기관삽관 환자의 비계획적 발관 예방프로그램을 개발하여 비계획적 발관율을 감소시키고 간호사들이 실무에서 비계획적 발관에 적극적으로 대처할 수 있도록 도움을 주기 위해 수행되었다. 조사기간은 사전기간이 2008년 5월부터 2009년 4월이었고, 프로그램 적용기간은 2009년 5월부터 2010년 4월로 각각 1년씩이었다. 기간 내 조사 대상 총 삽관환자는 사전시기와 중재 시기에 각각 330명, 332명이었으며, 이들 중 비계획적 발관을 경험한 사전 29사례와 적용기간 23사례에 대해 발관경험 환자와 담당간호사의 발관 관련 제 특성을 추가적으로 살펴보았다. 통계분석은 SPSS 18.0을 이용하였다. 비계획적 발관을 경험한 환자와 간호사의 제 특성은 유의한 차이를 보이는 것은 없었으나 두 시기에 신규 간호사의 진입 비율에 유의한 차이가 있었다($p=.039$). 기관내관 삽입 1000일당 비계획적 발관율은 신규 간호사 진입이 많았음에도 적용 기간의 평균이 8.8을 보여 사전 관찰시기의 평균 발관율 12.3과 비교하여 유의하게 감소($t=-2.333$, $p=.040$)하였으므로 본 연구의 결과는 중환자실 삽관환자의 비계획적 발관예방 활동을 통해 환자 안전에 기여할 수 있는 프로그램이라 사료된다.

주제어 : 비계획적 발관, 예방, 프로그램, 간호사, 중환자실

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Corresponding Author: Mi Yu (Namseoul University)

Email: yumichonsar@nsu.ac.kr

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1. Introduction

Intubation is a key lifesaving medical treatment in the Intensive Care Unit (ICU) of hospital, and planned extubation is only performed when a patients' condition, including lung function and hemodynamics, is sufficiently improved. However, there are diverse situations in which unplanned extubation (UE) occurs, such as self-extubation, in which patients remove the tube by themselves, or accidental extubation during nursing activities, transferring patients, and movement of patients [1, 4]. The frequency of UE ranges from 3% to 22.5% [2, 3]. Furthermore, as self-extubation makes up a higher proportion of UE cases [4], it creates a critical failure of airway patency, mechanical ventilation failure, and life-threatening cardiopulmonary complications. It is reported that immediate re-intubation is required in more than 50~60% of self extubation cases [4, 5].

When re-intubation is required, not only is the period of ventilatory support increased, but lengths of stay in the ICU are prolonged, and possibilities of complications and economic burdens increase, as well [6, 7]. Compared to those who do not experience UE, patients who undergo UE have to stay 3 days more in the ICU, and about 7 days more in the hospital. If re-intubation is performed 2 days after self-extubation, patients will require 7 additional days of ICU treatment, and the hospitalization period extends up to 15 days longer compared to those who do not require re-intubation. Most importantly, as re-intubation increases the mortality rate in hospitals about 30%, it is very critical to reduce UE [7]. That is, a proactive UE reduction strategy would contribute to a decrease in the hospitalization period and the rate of complications in the ICU [3, 8].

Prevention of UE in the ICU has been gradually recognized as an important matter and considered as an index of ICU medical service quality in the field of nursing for critically ill patients [9]. ICU staffs are

required to observe safety management techniques such as maintaining the correct position of the tube during intubation, opening the airway properly, applying appropriate sedatives and restraints, improving their skills something about medical procedures related to intubation and improving the intubation fixing method [2, 10].

Because UE may exacerbate a patient's conditions, cause embarrassment in nursing staff working in an ICU, and have a serious effect on the workflow in an ICU and on a patient's treatment plan by causing an emergency [11], one of the important duties of a nurse is to maintain intubation in an intubated patient [8]. So far, studies on the prevention of UE have been limited to the management of tube fixation [11, 12, 13] or on the education of nurses about the use of restraints [14, 15].

Recently, there is a growing need for a multidisciplinary approach by a health management team to successfully wean off a patient from mechanical ventilation while avoiding UE. However, there have been almost no studies on a stepwise approach to the performance of specific activities according to actual ICU situations. Such situations include frequently changing medical staff (physicians, medical interns, surgeons, etc.), UE prevention and identified factors which could be intervened by a nurse, management for newly assigned nurses in an ICU, intervention for a high level of anxiety caused by cases where verbal communication with patients is limited due to the intubation treatment, and other UE-related factors.

Therefore, in this study, we analyzed various UE-causing factors and developed and discussed an integrated UE prevention program for ICU nurses by investigating the environmental features of the ICU including the patients, and verified the applicability of the prevention program in an actual ICU, in order to help ICU nurses to carry out their nursing work.

2. Methods

2.1 Study design

The purpose of this study was to review a previous UE prevention program, and to develop and apply a new program to intubated patients hospitalized in ICU. Through the experience of applying the program to the actual ICU site, the features of the patients and nurses before and after UE were analyzed, and the effect of the prevention program on the UE rate was investigated.

2.2 Review of a previous prevention program and development of a new program

Prior to developing program, we reviewed previous studies and the related literatures as well as institutional reports within the previous three years, analyzed the results, and then developed the intervention contents of UE prevention program (UEPP). UEPP was developed based upon references to advanced research [8, 17], a UE prevention protocol developed by Song *et al* [16], and consultations with ICU expert who have worked in the field for more than 10 years. The program for ICU staff includes the importance of monitoring [8, 10], analysis of factors that influence UE [18], and practice hours on a restraint usage education program [14]. The change in the UE rate from the implementation of prevention program was investigated in this study. The UE rate was investigated during the preliminary investigation period from May 1, 2008 to April 30, 2009 and during the implementation of the prevention program from May 1, 2009 to April 30, 2010 with the intubated patients hospitalized in an ICU in the internal medicine department of a university hospital located in K Province, Korea. The features of the patients and the nurses who experienced UE during the two periods were also investigated.

2.3 Subjects

The subjects of this study were 330 patients who underwent intubation during the preliminary investigation period and 332 patients who underwent intubation during the implementation of the prevention program among patients. The subjects also included 29 patients and 23 patients who underwent UE during the preliminary investigation period and during the implementation of UEPP, respectively, and the nurses who were in charge of UE. After giving information about the purpose of study, voluntary participation, data were obtained from all participants who agreed to engage in the study.

2.4 Study tools

UE measurement tool is the Unplanned Extubation Report Form first developed by Richmond *et al* [17] which was corrected and complemented according to the on-site ICU circumstances and used to manage the performance index of internal medicine ICU quality management. The report form was completed after it was reviewed by two nurses and one chief nurse who had a career working in ICUs for more than ten years. UE rate was calculated as the number of UE days per 1000 intubation days.

2.5 Data analysis method

The data were analyzed with SPSS/WIN 18.0 software. The extubation-related features of the patients and nurses before and after the implementation of UEPP were presented as real numbers and percentages. T-test, chi-square test, and Fisher's Exact test were done to analyze the data. The UE rate before and after the implementation of the prevention UE prevention program was presented as real numbers and percentages. A one sample t-test was performed to analyze the data for the UE rate.

3. Results

3.1 Program contents

Prevention programs and processes have been developed following 5 steps: 1) education for nurses, 2) education & cooperation with other workers, 3) environmental support, 4) assessment and intervention for risk patients, and 5) monitoring and feedback [Table 1].

<Table 1> Unplanned extubation prevention program contents

Steps	Contents
1 step Education for nurses	1) The definition of unplanned extubation, factors, information on side effects 2) Report results for 3 years 3) Endotracheal tube fixed way, how to maintain 4) Restraint usage 5) Education R/T Analgesic, sedative drug education 6) Practice: proper restraint usage and fixation 7) Q&A, Problems, Improvements discussion
2 step Education & Cooperation with other workers	1) Cooperation with medical Doctors, professor 2) Primary physicians and interns: Risk factors R/T unplanned extubation, Guidance for prevention, Direct handout distributions 3) Request for communication R/T Restraints and sedatives orders with the nurses 4) The beginning of each month, primary care physician change, Repeated same activities.
3 step Environmental support	1) Every shifts, nurse should takeover the risk patients and verification process with 2 nurses 2) Attach labeling besides risk patients to protect other medical persons (interns, technologists)
4 step Assess and intervention for risk patients	1) Extubation risk assessment at handover : (Dual fixations and check of restraints) 2) Perform patient education about keeping his endotracheal tube 3) Emotional support of the patient 4) The need for sedatives and restraints
5 step Monitoring & Feedback	1) Monitoring Items decision :Restraint order, dual fixation method, UE risk labeling on the Weekly basis check 2) monitoring results Real-time feedback 3) At conference, announce UE rates and perform feedback and sharing the information with members

3.2 Comparison of the characteristics

In order to analyze the performance of our program in reducing the rate of UE, inpatient bed turnover rate, number of patients using ventilator, severity of illness and number of new nurses were compared in the periods before and after introduction of the program.

Among these factors, the number of new nurses showed a statistically significant difference ($\chi^2=2.093$, $p=.039$), while the other factors had no significant differences between pre and post periods. Based upon the analysis of actual score and percentage, there were no significant statistical differences between the characteristics of 29 patients who experienced UE in the pre stage (preliminary investigation) and those of 23 who experienced unplanned extubation in the post stage (implementation of prevention program) [Table 2].

<Table 2> Characteristics of unplanned extubation

Categories	Pre stage n(%)	Post stage n(%)	$\chi^2(p)$
Bed turnover rate(%)	101.7	101.2	NA
Respiratory use rate (%)	68.7	66.8	NA
Severity of illness(n)	Below 4	1886	1.530 (.222)
	Above 5	3936	
Number of new nurses(n)	5	13	2.093 (.039)
Sex	Male	20(69)	0.002 (.963)
	Female	9(31)	
Age (years)	19-60	10(31.0)	0.046 (.977)
	61-70	7(26.6)	
	> 70	12(41.3)	
Departments	Internal Medicine	21(72.4)	2.947 (.086)
	Neurology	8(27.6)	
Length of stay in ICU	1~9	15(51.7)	5.267* (.064)
	10-19	11(37.9)	
	20-30	3(10.3)	
Consciousness	Alert	23(79.3)	1.295 (.348)
	Confusion sleepy sedated	6(20.7)	
Mood	Calm cooperation	10(34.5)	0.949 (.330)
	Agitated, risky agitated	19(65.5)	

Use of sedatives	Yes	5(17.1)	5(21.7)	0.167 (.683)
	No	24(82.8)	18(78.3)	
Use of restraints	Yes	17(58.6)	14(60.9)	0.027 (.870)
	No	12(41.4)	9(39.1)	
Oxygen supply	AC/VC SIMV	8(27.6)	6(26)	0.046 (.977)
	PSV	13(44.8)	11(47.8)	
	CPAP T-piece	8(27.5)	6(26.0)	
Reintubation	Yes	19(65.5)	14(60.9)	0.119 (.730)
	No	10(34.5)	9(39.1)	

*Fisher's Exact test, AC/VC:(Assist Control/Volume Control), SIMV(Synchronized Intermittent Mandatory Ventilation), PSV(Pressure Support Ventilation), CPAP: Continuous Positive Airway Pressure

There were also no significant statistical differences when it comes to comparing work experience, nurses' job descriptions and numbers of patients under nurses' care in both pre and post stages [Table 3].

3.3 Comparison of the unplanned extubation rate

When comparing the UE ratio in 1000 intubated patients on a monthly basis in the pre and post stages, the frequency of UE decreased to 23 cases out of 332 intubated patients in the post stage, while in the pre stage the frequency of UE was 29 cases out of 330 intubated patients. The UE ratio dropped from 12.3 in the pre stage to 8.8 in the post stage, and this drop rate is statistically significant ($t=-2.333, p=.040$) [Table 4][Figure 1, 2].

<Table 3> Characteristics of nurses during unplanned extubation

Categories		Pre stage n(%)	Post stage n(%)	$\chi^2(p)$
Carrier (years)	Below 1	11(37.9)	10(43.5)	
	1-3	12(41.3)	6(26.1)	
	Above 3	6(20.7)	7(30.4)	
Work shift	Day	6(20.7)	8(34.8)	1.652 (.438)
	Evening	7(24.1)	6(26.1)	
	Night	16(55.2)	9(39.1)	

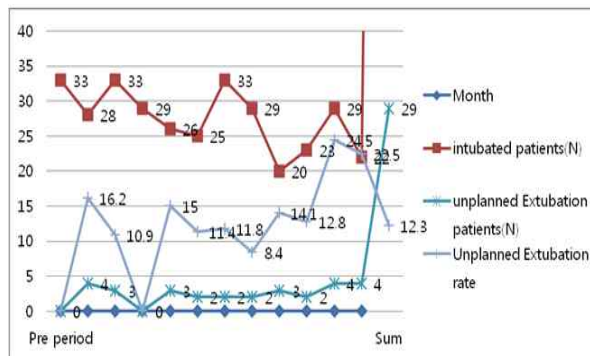
Nurse: patient ratio	1: 2	17(58.6)	16(69.6)	0.663 (.416)
	1: 3	12(41.4)	7(30.4)	
Situations	Handling of patients	19(65.5)	17(73.9)	0.831* (0.698)
	Besides of patients	5(17.2)	4(17.4)	
	Recording EMR etc. (Rest, take off gown)	5(17.2)	2(8.7)	

*Fisher's Exact test, EMR: Electrical Medical Record

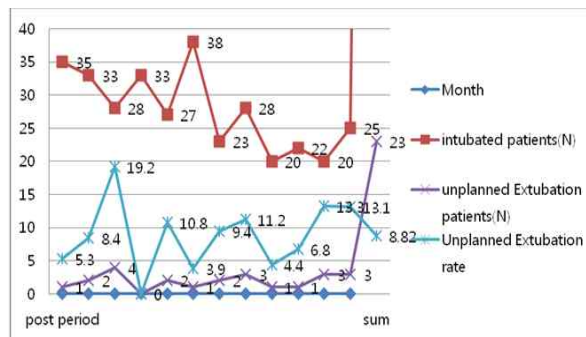
<Table 4> Comparison of the unplanned extubation rate

Category	Pre stage Mean(SD)	Post stage Mean(SD)	t	p
Unplanned extubation rate	12.30(7.384)	8.82(5.172)	-2.333	0.040

$p < .05$



[Fig. 1] Unplanned extubation rate in pre stage



[Fig. 2] Unplanned extubation rate in post stage

4. Discussion

4.1 Discussion of the prevention UE prevention program development

As an integrated prevention program to reduce UE, this program played a critical role in enabling newly hired nurses to receive both adequate training to prevent UE and feedback from monitoring execution.

The results were able to demonstrate that the prevention program could reduce UE by executing standardized process [17] in education on unplanned risk factors and patient safety [8, 19, 20, 21]. In addition, the program represents to apply an actionable protocol in terms of drawing fast action toward changes in patients' conditions and cooperation across various relevant medical service teams. The results support the findings of other studies that effective communication between medical service units is critical in order to increase patient safety in the ICU [17, 21].

In the ICU, not only nurses but also doctors are in charge of taking care of patients, meaning that proper education and tight cooperation between rotating medical service teams are essential [21]. Considering current service circumstances in the ICU, this study is recommending sound communication [21] when restraints and the administration of sedatives are necessary.

For the contents of the prevention program, we referred to previous studies on tube fixation methods [11, 12, 13], education and development of restraints, and UE-related factors. Above all, the analytical data for the causes of UE, which took place in the past three years in the institution, were used as the basis for the prevention program so that UE-related factors for which nurses could intervene. The ICU is a place where not only nurses but also many other medical staff such as physicians, medical interns, and surgeons are involved in taking care of the patients. Therefore, the need for educating and cooperating with the medical staff who were not fixed in ICU, was included

in the program so that communication between doctors and nurses who were in charge of the ICU patients could be carried out smoothly in the case of a treatment in which the use of a restraint or sedatives was required. In addition, because most of the patients hospitalized in the MICU have lucid consciousness, explanation and education about the emotional support and behavior of the patients, which were already discussed in previous studies [11], were considered to be important in the prevention program with regard to tube fixation and the restraints. The core part of the program was the periodic monitoring and feedback system, which were not provided through in a previous intervention study [16], enabling new nurses to approach a patient after receiving education and doing practice on UE prevention with a consistent protocol, even if the nurses may be frequently substituted.

4.2 Discussion of UE rate

In this study, the UE rate was reduced from 12.3 per 1000 days to 8.8. It was hard to make a direct comparison of the result with the various previously reported UE rates which included 11% [4], 2.14% [17], and 22.5% [3]. Song [16] reported the UE rate of 11.1 in the case of an intervention in an MICU, which was similar to the UE rate during the preliminary investigation in our study. The important thing is that the UE rate was significantly lower during the implementation of the prevention intervention program.

It is known that new nurses can affect the environment as well as the work attitude of other nurses, and these changes can threaten patients' safety in the ICU [21]. In the current study, even though the number of newly hired nurses increased to 13 in the post stage (compared to 5 in the pre stage), the UE rate was still significantly decreased from the pre stage to the post stage. The results also support various advanced research findings highlighting the importance of training ICU staff members [8, 17, 20, 21]. In other research [20], it showed that standardization of process,

education, and risk management can reduce the frequency of UE in the ICU. Implementation of educational or quality improvement programs is expected to advance ICU staff members' knowledge about risk factors for UE, promote skills on safe, standardized procedures for patient care and increase compliance with them [19].

5. Conclusions

The start of a new nurse in the ICU means a change in the working environment of the ICU. As a result, it is possible that the severity of the patients could increase, and the number of times intubation is required could increase due to the inexperience of the new nursing staff. The work environment including the work responsibilities of fellow nurses is affected because the number of new inexperienced ICU nurses has increased due to the change in the ICU nurse human resources structure. Therefore, the result that the mean UE rate was significantly reduced despite the frequent changes in inexperienced ICU nurses indicated that the prevention activity through the prevention program was effective. The results of this study provide a prevention program that could contribute to the safety of patients by actively preventing UE in intubated patients hospitalized in the ICU.

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강 경 자(Kyung-ja Kang)



- 1993년 2월 : 서울대학교 간호학과 (간호학사)
- 2009년 2월 : 서울대학교 간호대학원 간호학과 (간호학박사)
- 2013년 3월 ~ 현재 : 제주대학교 간호대학 조교수
- 관심분야 : 시뮬레이션, 환자교육, 노인, 동기강화상담

· E-Mail : kkyungja@jeju.nu.ac.kr

유 미(Yu, Mi)



- 1991년 2월 : 서울대학교 간호학과 (간호학사)
- 2006년 8월 : 서울대학교 간호대학원 간호학과 (간호학박사)
- 2010년 9월 ~ 현재 : 남서울대학교 간호학과 조교수
- 관심분야 : 중환자간호, 조직행동, 인적자원관리

· E-Mail : yumichonsa@nsu.ac.kr