

# Development and Application of Checklist to Prevent Unplanned Removal of Drainage Tubes

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## Abstract

**Purpose:** This study aimed to develop and apply checklist for prevention of unplanned removal of drainage tubes inserted, following head surgery. **Methods:** A literature review, focus group interviews, analysis of medical records, confirmation of validity, and clinical applicability were used to develop the checklist, which was tested using a quasi-experimental design. After providing the intervention to the subject who inserted the drain tube, the rate of removal, satisfaction, perception and performance were measured. Collected data were analyzed using paired t-test. **Results:** The final checklist was derived from five domains: general characteristics, patient's condition and characteristics of disease, treatment, drainage tube, and nurse/environment. As a result of applying this checklist, unplanned removal of drainage tube did not occur. Satisfaction of nurses who used the checklist was recorded as high. Perception and performance of the nurses on the prevention of unplanned removal of drainage tube was significantly increased after applying the checklist before applying it. **Conclusion:** This study provided an opportunity to recognize the importance of drain management of head surgery patients and suggests that this information will be used as basic data on the drain management practices.

**Keywords:** checklist, prevention, drainage, head, surgery

## INTRODUCTION

Head surgery is any surgery which includes surgical access to the internal structure of the head, and includes various types, including craniotomy, craniectomy, transsphenoidal approach, cranioplasty, and ventricular shunt [1]. During such surgeries, a tube is often inserted to promote the healing of surgical wounds by discharging secretions, such as blood, plasma, pieces of tissue that cause swelling, pain, and infection, as well as to prevent the accumulation of discharge in the human body after surgery. Drainage is achieved through methods utilizing gravity, natural drainage, or intermittent suction, or by connecting a device to remove material by direct suction from the affected area [2]. The tube used differs depending on the purpose of drainage, the depth and width of the affected part, and the type of drainage required, such as external ventricular drainage, Jackson pratt drain, Hemo-vac etc. Once the drainage tube is inserted, it is maintained from as short as a day to as long as a week or more, whilst, meanwhile, the pattern and amount of drainage is assessed.

It is during this process that unplanned extubation can occur.

This can mean self-extubation, whereby the inserted tube is removed by the patient themselves, regardless of the intentions of the therapist, or accidental extubation, whereby the inserted tube is removed by chance in practice, such as by position changes, patient transport, x-ray, or testing process [3]. Patients undergoing head surgery may experience sequelae, such as confused state for a long term period or unconscious state, paralysis or numbness, occasional instability, and irritable behavior, depending on the severity of the [4]. As such, during the period with the inserted drainage tube, it is necessary to continue to manage and monitor the drainage tube so that its function can be maintained until its intended removal time. The frequency of unplanned extubation of the drainage tube inserted after head surgery have never been reported; however, it is known to occur often in clinical practice. During the acute period following head surgery, bleeding can occur following the unplanned extubation of the drainage tube. In addition, if hematoma in the surgical site is increased, it can cause neurological defects, such as decreased levels of consciousness or motor function, causing secondary injury such as increased intracranial pressure (IICP), cerebral edema, or cerebral tissue injury [5]. The degree of damage due to unplanned extubation of the drainage tube varies depending on the condition of the patient prior to the extubation, from mild to fatal damage. Even though medical personnel can react to the emergency to provide an immediate solution, future complications may remain. The risk of complications, such as respiratory problems and postoperative infection, is increased following reoperation [6]. As such, unplanned extubation of the drainage tube requires special attention as it can increase hospital stay and the economic burden on the patient by aggravating the condition or delaying recovery, as well as a potential negative effect on the relationship between the medical personnel and the patient. The method most easily used by nurses to prevent unplanned extubation of unstable patients is to apply physical restraints [7]; however, if the patient restrains, care should be taken to avoid side effects, such as bruising, cuts, swelling, abrasions, and redness [8]. Sometimes, chemical restraints, such as psychotropic drugs (sedatives, hypnotics, etc.), are also used [9], although not routinely as they can increase the difficulty to differentiate the recovery of consciousness after head surgery.

Unplanned extubation may worsen the patient's condition, as well as have a negative effect on the treatment plan of the patient, or on the work flow by causing an emergency [10]. As

such, it is necessary to better manage and monitor the device inserted or attached to the patient, for the prevention of unplanned extubation [11]. In particular, ICU nurses need a proactive system in place to predict and cope with changes by observing the patient's condition [12]. In order to prevent unplanned extubation occurrences in an instant in the ICU, it is important to develop effective methods to continuously manage the patient's situation [13]. Also, medical personnel should be responsible for the maintenance of drainage tubes and check the openness and insertion state of the drainage tube until intentional extubation occurs. Unplanned extubation of endotracheal tubes has been recognized as an important issue, and as such is rated as one of quality indicators of the ICU healthcare service [14], but management of the insertion tube after surgery remains unnoticed. The purpose of this study was to develop a nursing intervention for the accident prevention of unplanned extubation of drainage tubes that will promote the safety of the patient after surgery, and can help alleviate negative effects on the treatment course.

## **METHODS AND RESEARCH MATERIALS**

### **Design**

This study is quasi-experimental research to develop and apply a checklist for the prevention of unplanned removal of drainage tubes inserted during head surgery.

### **Setting and participants**

Participants were patients and nurses working in the neurological ICU at a University Hospital, between October and December, 2013. Selection criteria are as follows; 1) Patients with a drainage tube after hair surgery 2) Patients and nurses consented to participate. The final subjects included in the data analysis were 110 patients (all patients who met the selection criteria during the study period) with a drainage tube after hair surgery and 37 neurological ICU nurses (all nurses except head nurse and charge nurse).

## **INSTRUMENTS**

### **Incidence of unplanned removal**

The incidence of unplanned removal is given as a value represented as a percentage of the number of unplanned removal for all patients with a drainage tube inserted.

### **Satisfaction with the use of the checklist**

Satisfaction with the use of the checklist was measured using a modified version of a tool developed by Paul [15]. The tool consisted of 4 questions. Each question is answered using a 5-point scale; where a high score indicates a high degree of satisfaction. Cronbach's alpha coefficient of this tool was .87.

### **Nurse's perception and performance on prevention of unplanned removal**

Nurse's perception and performance on prevention of unplanned removal was measured by a tool developed based

on the content of checklist. Perception was composed of risk and clinical outcomes of unplanned removal, assessment, management, communication and cooperation among medical personnel, and education and practice guidelines domain, total 30 questions (Cronbach's alpha was .93). Performance was composed of assessment, management, and communication and cooperation among medical personnel domain, total 25 questions (Cronbach's alpha was .92). Each question regarding the recognition and execution was answered using a 5-point scale. A high score in the survey indicates a high degree of perception and performance.

## **Data collection and methods**

### **Checklist development**

In order to understand the prevention methods and risk factors affecting unplanned removal of drainage tubes inserted after head surgery we carried out a review of the literature, focus group interviews, and analysis of electronic medical records. There was no previous research related to the unplanned removal of drainage tubes until now, and therefore we reviewed the literature related to the unplanned removal of endotracheal tube. Participants who took part in the focus group interviews were ICU nurses with a varied clinical career such as less than 3 years and less than 3-5 years, less than 5-7 years, less than 7-10 years, and more than 10 years. Participants were 2 persons for each clinical career, and total 20 persons. The focus group interviews were conducted in two groups (10 people per group) and twice by one week intervals. The main question was 'what are the risk factors and effective prevention methods that affect the unplanned removal of the drainage tube inserted after head surgery?'. Analysis of the medical records was performed in 10 patients with unplanned removal, and 50 patients with planned removal, among the patients who had a drainage tube inserted after head surgery. Four researchers independently analyzed each and then they reviewed the analysis together. The risk factors and occurrence situation of unplanned removal, as well as the management methods of drainage tubes, were identified. After deriving a checklist of nursing interventions to prevent, assess and manage the risk of unplanned removal through this process, we verify the content validity and the clinical validity. In order to verify the content validity of our checklist development we selected 10 experts on the basis of the literature, that states that at least 3 people and up to 10 people is appropriate. The content selected for the checklist included all agreed items with expert CVI (content validity index) of more than 0.8 [16]. In order to verify the clinical applicability, the developed checklist was applied to 30 head surgery patients having an inserted drainage tube in October 2013. In addition, the final content of the checklist was confirmed on the basis of whether the activities were carried out successfully in practice. From this we developed a final checklist. The final checklist consists of the following 5 domains: 1) general characteristics, 2) patient's condition and characteristics of disease, 3) treatment, 4) drainage tube, 5) nurse and the environment<see Figure 1>.

\* Write down the following items.

However, please check the 'Yes' or 'No' or 'NA' from 2 to 5 times. If 'No', describe the reason.

#### 1. Domain related to general characteristics

- 1) Age
- 2) Gender
- 3) Diagnosis
- 4) Operate name
- 5) Kind of drainage tube
- 6) ICU days
- 7) Hospital days

#### 2. Domain related to the patient's condition and characteristics of disease

- 1) Assess the GCS, communication.  
If the level of consciousness is not clear, the nurse will mediate properly after consultation with the doctor in charge.
- 2) Assess the behavior.  
If the patient is unstable or agitated, the nurse will mediate properly after consultation with the doctor in charge.
- 3) Assess the sedation.  
If the patient is excited, the nurse will mediate properly after consultation with the doctor in charge.
- 4) Assess the intensity and characteristics of pain.  
If necessary, the nurse will control and discuss the pain with doctor.
- 5) Assess the delirium.  
If the patient exhibits delirium symptoms, carefully observe and mediate.  
Assess the severity.
- 6) Consider ways such as, the assignment of an experienced nurse, the number of patients per nurse, and workload adjustment, if the severity of the patient is high.
- 7) Assess the history of the unplanned removal.  
If the patient has a history of unplanned removal, observe carefully.

#### 3. Domain related to treatment

- 1) Assess the need for sedation  
If necessary, the nurse administers the prescribed sedative to the patient after consultation with the doctor in charge.
- 2) Assess the need to use restraints.  
If necessary, the nurse applies the prescribed restraint to the patient after consultation with the doctor in charge.
- 3) Check the planning for the moving out of the ICU.  
Be careful when moving out of the ICU. Record precautions and risk factors in a checklist and communicate with transport employees.  
Check the planning for the procedure in bed
- 4) When procedure in bed, should attend the following: status of drainage tube inserted, communicate about the precautions and risk factors with the staff involved.  
Check the planning for the imaging tests in bed.
- 5) When imaging in bed, one should attend the following: status of drainage tube inserted, communicate about the precautions and risk factors with the staff involved.

#### 4. Domain related to drainage tubes

- 1) Assess the fixed state of drainage tube.  
If drainage tube is poorly fixed, drainage tube should be securely fixed again.
- 2) Assess the fixed drainage bag in accordance with the drainage purposes.  
If drainage bag is poorly fixed, drainage bag should be securely fixed again.
- 3) Assess the state of dressing.  
If the state of dressing is poor, discuss the problem with your doctor. And if necessary, nurse helps your doctor to do the dressing.
- 4) Check the number of drainage tubes and assess the amount and characteristics of drainage.  
Periodically evaluate the need for drainage tube inserted with your doctor.

#### 5. Domain related to the nurse and the environment

- 1) If the patient is at high risk of unplanned removal, the patient is assigned to a career nurse.
- 2) If the patient is at high risk of unplanned removal, the nurse in charge of the patient is assigned a small number of patients.
- 3) If the patient is at high risk of unplanned removal, the patient should be placed in a well visible position. Then attach a warning sign to the patient's bed.
- 4) If the nurse is leaving the patient, the nurse takes over the patient status using SBAR to the colleagues.
- 5) If there are many nursing services provided to patients, share the nursing work or requests for help from colleagues.
- 6) The nurse in charge should pay more attention to the time because unplanned removal have been reported to occur frequently around one hour after takeover.
- 7) The nurse in charge should pay more attention to the time because unplanned removal have been reported to occur frequently in the evening and night.

ICU: Intensive Care Unit, GCS: Glasgow Coma Scale, SBAR: Situation-Background-Assessment-Recommendation

**Figure 1.** Checklist to Prevent Unplanned Removal of Drainage Tube of Patients with Head Surgery

### Checklist application and data collection

This checklist was evaluated by applying a target of 110 patients admitted to the ICU after having had a drainage tube inserted into the head in a tertiary teaching hospital between December 1, 2013 and March 31 2014. The researchers conducted the study after explaining the purpose and significance of the research and the method of application of developed checklist to neurological ICU nurses during a conference. The neurological ICU nurses checked the performance status of all items using a checklist for each patient with a drainage tube inserted. If the nurse did not carry out the checklist items, it was recorded with a reason. For thorough data collection, the duty charge nurse checked whether or not the checklist item was carried out.

### DATA ANALYSIS

Data were analysed using SPSS statistics ver. 21 program. The content validity of checklist was identified as CVI. The incidence of unplanned removal was estimated by the number and percentage. Satisfaction with use of the checklist was analyzed by mean and standard deviation. The difference between the nurse's perception and performance on prevention of unplanned removal were analysed via paired t-test.

### ETHICAL AND RESEARCH APPROVALS

This study was approved and authorized by the institutional review board, and all participating patients provided signed informed consent. Consent to participate was obtained from all nurses using the developed checklist, patients receiving the developed checklist and patients' families after providing explanation on the study objectives, significance and overall content.

### RESULTS

#### Participants' Characteristics

The general characteristics of the participants who had a drainage tube inserted are given in <Table 1>.

#### Unplanned removal rate of drainage tube

Unplanned removal of the drainage tube did not occur among 87 patients, except for 23 patients who transferred to the general ward with the drainage tube still inserted <Table 2>.

#### Satisfaction with use of the checklist

The scores of all items except " The checklist is adequate for use by the ICU nurses " were higher than 4 points out of 5 points. In other words, nurses responded that the checklist is adequate for the ICU setting, drain management of head surgery patients and allows for management and resolution of the individual complaints of head surgery patients with

drainage tube. However, the score of "The checklist is adequate for use by the ICU nurses" was the lowest with 3.95 out of 5 points <Table 3>.

**Table 1.** General Characteristics of Subjects (N=110)

Characteristics	Range	n (%) or Mean ± SD (range)
Gender		
Male		59 (53.6)
Female		51(46.4)
Age (years)		55.06 ± 16.15
≤30		9 (8.2)
31-40		10 (9.1)
41-50		15 (13.6)
51-60		34 (30.9)
≥61		42 (38.2)
Diagnosis		
Subarachnoid hemorrhage		22 (20.0)
Unruptured intracerebral aneurysm		24 (21.8)
Brain tumor		35 (31.8)
Intracerebral hemorrhage		20 (18.2)
Others		9 (8.2)
Length of stay in the neurocritical care unit (days)		7.32 ± 8.71
Length of stay in hospital (days)		17.55 ± 11.58
Number of drainage tubes		
1		77 (70.0)
≥2		33 (30.0)
Type of drainage tube*		
External ventricular drainage		34
Hemo-vac		74
Jackson-Pratt drainage		19
Subdural drainage		10
Period of insertion (days)†	1~14	3.72 ± 3.03 (1~14)
1-2		53 (48.2)
3-5		31 (28.2)
≥6		26 (23.6)

\* If there is more than 1 drainage tube, the drainage tube was included in all.

†Period of insertion: If there is more than 1 drainage tube, the drainage tube with the longer insertion period was recorded.

#### Nurse's perception and performance on prevention of unplanned removal

Perception had increased to 4.40 points after the application, from 4.11 points before the application, out of a total of 5 points (p=.001). In detail, risk and clinical outcomes of unplanned removal increased to 4.43 points after the

application, from 3.89 points before the application. Assessment has increased to 4.45 points after the application, from 4.11 points before the application. Management had increased to 4.43 points after the application, from 4.24 points before the application. Communication and cooperation among medical personnel had increased to 4.31 points after the application, from 4.03 points before the application. Education and practice guidelines had increased to 4.32 points after the application, from 3.80 points before the application.

Performance had increased to 4.46 points after the application, from 3.86 points before the application, out of 5 points ( $p=.001$ ). In detail, assessment had increased to 4.51 points after the application, from 3.84 points before the application. Management had increased to 4.47 points after the application, from 3.92 points before the application. Communication and cooperation among medical personnel had increased to 4.39 points after the application, from 3.76 points before the application ( $p<.001$ ) <Table 4>.

**Table 2.** Unplanned Removal Rate of Drainage Tubes (N=110)

Intervention items		SAH (n=22)	UIA (n=24)	Brain tumor (n=35)	ICH (n=20)	Others (n=9)	Total (n=110)
		n (%)					
Unplanned removal rate	Yes	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
	No	22 (100)	24 (100)	12 (34.3)	20 (100)	9 (100)	87 (79.1)
Planned removal rate	Yes	0 (0.0)	0 (0.0)	23 (65.7)*	0 (0.0)	0 (0.0)	23 (20.9)*
	No						

SAH: Subarachnoid Hemorrhage, UIA: Unruptured Intracerebral Aneurysm, ICH: Intracerebral hemorrhage

\*23 patients were transferred to the general ward with a drainage tube. They were planned removal in general wards.

**Table 3.** Satisfaction with Use of the Checklist (N=37)

Items	Mean ± SD
The checklist is adequate for drain management of head surgery patients	4.38 ± 0.67
The checklist is adequate for the ICU setting	4.35 ± 0.74
The checklist allows for management and resolution of the individual complaints of head surgery patients with drainage tube	4.08 ± 0.75
The checklist is adequate for use by the ICU nurses	3.95 ± 0.73

ICU: Intensive Care Unit

**Table 4.** Nurse's Perception and Performance on Prevention of Unplanned Removal (N=37)

Variables	Pre-test	Post-test	t	p
	Mean ± SD			
<b>Perception</b>	4.11 ± 0.33	4.40 ± 0.38	4.43	.001
The risk and clinical outcome of unplanned removal	3.89 ± 0.48	4.43 ± 0.43	5.89	<.001
Assessment	4.11 ± 0.44	4.45 ± 0.43	4.20	<.001
Management	4.24 ± 0.35	4.43 ± 0.42	2.83	.008
Communication and cooperation among medical personnel	4.03 ± 0.39	4.31 ± 0.47	3.53	.001
Education and guidelines	3.80 ± 0.56	4.32 ± 0.52	4.54	<.001
<b>Performance</b>	3.86 ± 0.37	4.46 ± 0.39	8.05	.001
Assessment	3.84 ± 0.47	4.51 ± 0.38	7.69	<.001
Management	3.92 ± 0.40	4.47 ± 0.41	7.14	<.001
Communication and cooperation among medical personnel	3.76 ± 0.42	4.39 ± 0.43	7.06	<.001

## DISCUSSION

In this study, we developed a checklist to prevent unplanned drainage of the patients who had inserted the drainage tube during hair surgery and to help the treatment process and the effective of the developed checklist was evaluated in practice. This checklist has been developed through systematic stages. First, we reviewed literature related to unplanned removal to identify the rationale for the contents of checklist. Then we identified various cases related to unplanned removal of drainage tube by analyzing the medical records of the patients who inserted the drainage tube after head surgery. In addition, we conducted focus group interviews with nurses to discuss the preventive activities, problems, and remedies that are being implemented in practice. The contents of the preliminary checklist has been derived through this process and we applied a preliminary checklist to the patient who inserted the drainage tube after head surgery. As a result, most of the contents of the checklist were being performed, but assigning patients with high risk of unplanned removal to experienced nurse was often not performed. Nurses have pointed out that it is not easy to change the charge nurse every time according to the patient's condition. They said that if the nurse changes each time, the efficiency of the work may be reduced and the working environment may not be supported, such as the lack of career nurses. However, in previous studies, low careers of nurses were considered to be risk factors for unplanned removal [17]. An item that assigns a career nurse to a patient at high risk of unplanned removal [18] was included in the preliminary checklist. The expert group verified the content validity of the developed preliminary checklist. The expert group advised that all factors affecting the unplanned removal of the drainage tube should be included in the checklist. Accordingly, we included factors related to patients, treatment, drainage, nursing and the environment that were suggested as factors affecting the unplanned removal in previous studies [19] in the checklist. After verifying the validity applicable to the preliminary nursing intervention intended for 30 patients who had a drainage tube inserted by neurological ICU nurses, following head surgery, the preliminary nursing intervention was confirmed as having no problems for use in practice and, as such, was confirmed as the final nursing intervention. The NCU nurses verified the clinical validity by applying a preliminary checklist to 30 patients who inserted drainage tube after head surgery. As a result, the preliminary checklist was confirmed to be the final checklist because it was no problem in practice.

As a result of applying the checklist developed in this study to patients who inserted the drainage tube into the head, unplanned removal did not occur however, the checklist developed in this study should be used consistently in practice, as well as being considered in parallel to evaluate its effect. Kang and Yu [20] developed an education program to prevent unplanned removal. The contents of the education program consisted of 5 steps as follows; 1) education for nurses, 2) education & cooperation with other workers, 3) environmental support, 4) assessment and intervention for risk patients, 5) monitoring and feedback. After applying this education program to nurses, unplanned removal were significantly decreased. Also, the results of applying a continuous quality improvement program in previous studies of unplanned

removal was a reduction of 22-53% [21]. These included a variety of interventions, including the development of tools for data collection, standardization of procedures, medical personnel education, medical personnel monitoring, and the identification and management of high-risk patients of unplanned removal (da Silva and Fonseca, 2012) [21]. The tools to assess the risk factors for unplanned removal allow systematic screening of patients for high risk factors of unplanned removal [22]. In this study, satisfaction with the use of the checklist was high with more than 4.0 points out of 5 points. However, questions, such as 'The checklist is adequate for use by the ICU nurses' was the lowest score, with 3.95 points. As a result of analyzing the reasons, nurses with low experience said they felt burdened because they regarded activities to prevent unplanned removal as complex tasks. In order to solve this problem, it is important to recognize that it is necessary to perform the management activity by using checklist, and it is necessary to provide training to perform the checklist skillfully. Through the education program, nurse's knowledge of risk factors can be improved and education programs should be carried out in the first phase of the preventive activity. These education programs can be combined with daily rounds to assess the risk levels of patients for unplanned removal and discuss documented episodes of unplanned removal as reference points. This can provide implications for clinical practice [23]. In this study, perception and performance of nurses for the prevention of unplanned removal of the drainage tube was significantly increased after applying our checklist. This is presumed to be the result of nurses naturally recognizing the importance of drain management as nurses frequently use this checklist, and this seems to be connected to performance naturally. Unplanned removal is sensitive to organization factors related to the procedures of nursing resources, problems of human resources and the standardization of care. In this context, it should be made easier to continue training in order to promote the safety of drainage tube fixation and proper application of nursing intervention [19].

This study developed checklist for the ultimate purpose of helping the healing of surgical wounds and improving the safety of the patient through the proper management of the drainage from head surgery, so that removal of the drainage tube is carried out according to the plans of the physicians. Unplanned removal is one of the medical incidents that often occur in practice and it is an important issue that directly affects patient safety. Therefore, medical personnel should be concerned with the management of drainage tubes and should also focus on preventing unplanned removal. In order for this checklist to be actively used in clinical practice, continuous management such as periodic checklist revision, medical personnel training and monitoring is required.

## LIMITATIONS

The limitations of this study were, first, only patients with drainage tube inserted after head surgery and neurological ICU nurses from a single hospital were selected. Second, the effect of applying the checklist was evaluated without a control group.

Third, this study is the result of a short period of time, so

further research is required to support this study. Therefore, it is necessary to pay attention to the interpretation and generalization of the results of this study. Despite these limitations, this study has the following significance. Until now, studies on the unplanned removal of the endotracheal tube have been actively carried out, but studies on the unplanned removal of the drainage tube have been rarely conducted. In this respect, the significance of this study is that it extended the scope of unplanned removal. Also, the checklists developed in this study were developed through a systematic process, so the contents of the checklist are concrete and practical.

## CONCLUSION

In this study, we developed a checklist to prevent of unplanned removal that can occur in patients following the insertion of a drainage tube after head surgery. The contents of the checklist were derived from risk assessment and continuous management to prevent unplanned removal through review of related literature, focus group interviews and medical record analyses. Preliminary checklist has been developed based on this process after confirming whether it should be performed in practice. The final checklist was developed through a process to evaluate the content validity and clinical validity from experts and practitioners. The final checklist consisted of 5 domains. As a result of applying this checklist, unplanned removal of the drainage tube did not occur. Satisfaction of nurses who used the checklist was recorded as high and the perception and performance of the nurses on the prevention of unplanned removal was also significantly increased. In conclusion, this checklist has been shown to assist in preventing the unplanned removal of drainage tube.

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