



Brief Communication

## Development of an Intrasystemic Team Resource Management Program to Reduce Accidental Catheter Removal in a Critical Care Unit: A Stepwise and Evidence-Based Approach

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### SUMMARY

We aimed to develop a team resource management (TRM) program that is logistically more efficient; we did so through the investigation of intrasystemic risk factors and through providing evidence-based support. We evaluated the program's clinical effects on accidental catheter removal (ACR) in an intensive care unit (ICU) of a medical center. Before developing the TRM program, we used a 3-year ICU dataset to identify 46 patients and 48 events of ACR comprising 65.2% endotracheal tubes and 19.6% central venous catheters. Through an assessment of baseline characteristics, we observed the following intrasystemic problems: inadequate communication to patients, insufficient identification of high-risk patients, lack of chemical sedation for eligible patients, discordant ICU team workflow and cross-monitoring, and inadequate professional training. A problem-targeting, multifaceted TRM program was implemented in an ICU in April 1, 2019, following an estimation of its clinical effectiveness through systematic review and meta-analysis. The ACR incidence remarkably decreased after implementing the TRM program; five ACR cases in 2017, five in 2018, one in 2019, and two in 2020. In this study, we demonstrated a reliable strategy of TRM program development to reduce ACR in the ICU.

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## 1. Introduction

Accidental catheter removal (ACR) is a major patient safety concern, often causing harm or posing a danger to the patient's life.<sup>1,2</sup> Critically-ill patients are at risk of ACR because of confused status and multiple indwelling catheters.<sup>3</sup>

The implementation of a single protocol may not effectively reduce the incidence of ACR in the intensive care unit (ICU) owing to complicated mechanisms and heterogeneous risk factors across various health care systems.<sup>4,5</sup> In this study, we developed a team resource management (TRM) program that is logistically more efficient through the investigation of intrasystemic risk factors and through providing evidence-based support. We then evaluated its clinical effects on ACR in an ICU.

## 2. Methods

This before-and-after study was performed in a 12-bed cardiac ICU (or cardiac care unit [CCU]) in a medical center in northern Taiwan. The data were collected retrospectively with the approval of the local Institutional Review Board (21MMHIS099e). All patients were cared by an ICU-specific team, including two full-duty intensivists, trained nurses, one pharmacist, one social worker, one psychological consultant, and three respiratory therapists. The nurse-to-patient ratio was 1:2.6.

First, we retrospectively analyzed all ACR cases in all adult ICUs from January 1, 2016, to December 31, 2018 to identify the intrasystemic risk factors in our institute. We explored potential differences between our CCU and other ICUs. Third, a TRM group comprising intensivists, all CCU nurses, a pharmacist, a psychological consultant, and respiratory therapists was formed to develop approaches to target the salient clinical-practices problems. Fourth, the clinical benefits of modified management were predicted using a systematic review and meta-analysis. Since April 1, 2019 to the time of writing, we have performed a TRM-based quality improvement program in one CCU. Any occurrence of ACR was recorded and estimated with the exception of events involving nasogastric tubes and peripheral intravenous catheters. Quantitative variables were expressed as their mean and standard deviation, and qualitative variables were presented as their frequency and percentage. Comparisons of continuous variables between groups were performed using an analysis of variance. The two-tailed alpha significance level was 0.05.

## 3. Results

A total of 46 patients and 48 ACR events were identified. Dislodgements of an endotracheal tube (ET; 65.2%) and central venous catheter (CVC; 19.6%) constituted most ACR events. Table 1 presents the baseline characteristics of patients who experienced ACR, representing the risk factor of old age, male sex, lower education level, and less intravenous sedation (even without spontaneous breathing training on mechanical ventilation support). The adequate sedation

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**Table 1**  
Baseline factors associated with ACR according to ICU type.

Factors	Total (N = 46)	CCU (N = 12)	Non-CCU (N = 34)	p
Age > 70	27 (58.7%)	8 (66.7%)	19 (55.9%)	0.514
Male, n (%)	32 (68.1%)	8 (66.7%)	24 (70.4%)	0.800
Less education, n (%)	26 (55.3%)	8 (66.7%)	18 (52.9%)	0.374
Alcohol	11 (23.4%)	4 (33.3%)	7 (20.6%)	0.410
BMI	23.8 ± 4.1	24.4 ± 3.9	23.7 ± 4.2	0.636
APACHE II	24.2 ± 7.3	23.3 ± 9.2	24.6 ± 6.7	0.656
RASS ≥ 1	23 (50%)	4 (33.3%)	19 (55.9%)	0.179
Diagnosis				
Infection	23 (50%)	3 (25%)	20 (58.8%)	0.044*
Acute GI bleeding	7 (15.2%)			
Acute heart failure	19 (41.3%)	8 (66.7%)	11 (32.4%)	0.038*
Acute renal failure	18 (39.1%)	5 (41.7%)	13 (38.2%)	0.834
Acute stroke	3 (6.5%)			
Sedation				
IV sedation	8 (17.4%)	2 (16.7%)	6 (17.6%)	0.939
Oral sedation	12 (26%)	6 (50%)	6 (17.6%)	0.028*
Physical restraint				
Upper limbs	31 (61.3%)	8 (66.7%)	23 (67.6%)	0.950
Lower limbs	7 (15.2%)			
MV control <sup>#</sup> without IV sedation	24/28 (85.7%)	6/6 (100%)	18/22 (81.8%)	0.259
PN1	37 (80.4%)	11 (91.7%)	26 (76.5%)	0.254
Non-morning shift	36 (78.3%)	11 (91.7%)	25 (73.5%)	0.190

\* p < 0.05.

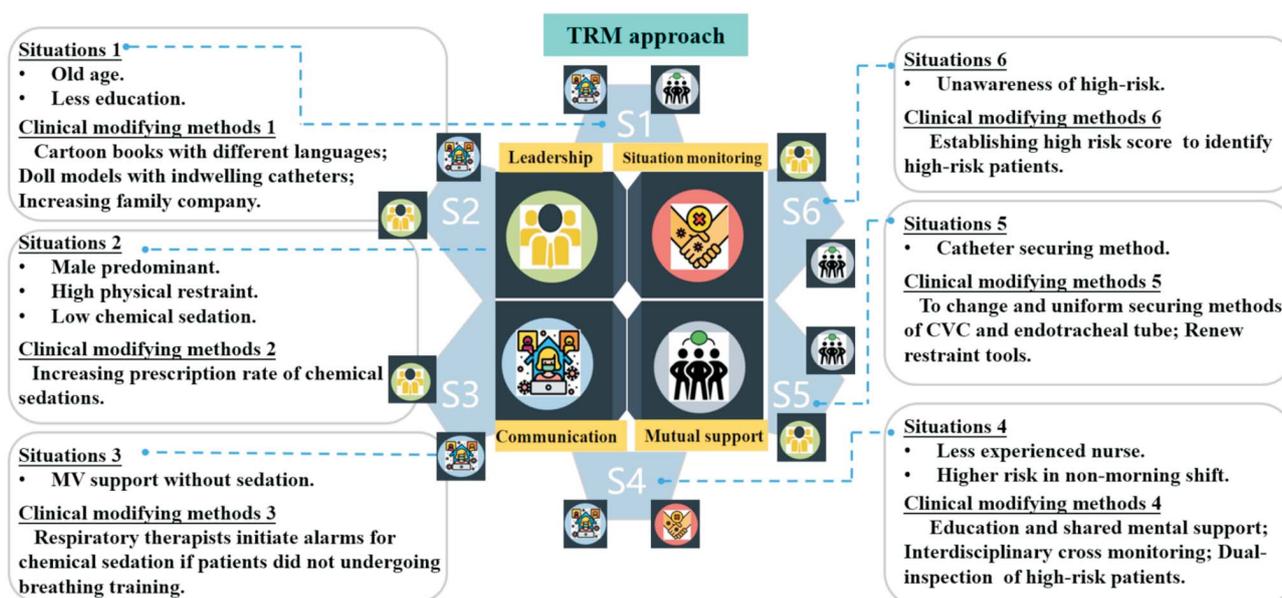
<sup>#</sup> Patients rested completely on mechanical ventilation support without undergoing spontaneous breathing training.

Abbreviation: ACR: accidental catheter removal; APACHE: Acute Physiology and Chronic Health Evaluation; BMI: body mass index; CCU: cardiac care unit; GI: gastrointestinal; ICH: intracranial hemorrhage; ICU: intensive care unit; IV: intravenous; MV: mechanical ventilation; PN1: practical nursing 1; RASS: Richmond Agitation Sedation Scale.

rate was reported 44.7% in UK compared to ours of less than 20%.<sup>6</sup> ACR usually occurred during the nonmorning shifts staffed with younger and less experienced nurses. The risk factors of the CCU were similar except for the higher level of oral sedative prescription (p = 0.028). These risk factors indicated the following critical intrasystemic problems: inadequate communication with patients, insufficient identification of high-risk patients, a lack of chemical sedation for eligible patients, discordant ICU team workflow and cross-monitoring, and inadequate professional training. A multifaceted program was therefore warranted to address these problems. Con-

ducting a systematic review and meta-analysis, we observed that a multifaceted intervention can effectively lower accidental removal of ET by 50% (data not shown), with a continual quality improvement of 22%–55%.<sup>5</sup> Hence, a TRM program have been proposed and implemented into CCU clinical practice since April 1, 2019; the program is detailed in Figure 1. CCU team members must pay increased attention to the safety of patients with indwelling catheters.

Figure 2A indicates the TRM program performance of each team, which was assessed using a mutual evaluation form. Overall, the accurate executive rate reached over 95% in all aspects. The



**Figure 1.** Modifications of clinical practices targeting clinical situations based on TRM methods. Six clinical situations were identified as intrasystemic problems. Modifications of clinical practices targeted at the problems were developed based on selected TRM approaches. CVC: central venous catheter; MV: mechanical ventilation; TRM: team resource management.



**Figure 2.** Clinical results in CCU after implementation of the TRM program. (A) Accurate executive rate reached over 95% in all aspects of TRM. (B) Annual ACR incidences of (C) central venous catheter and (D) endotracheal tube. ACR: accidental catheter removal; CCU: cardiac care unit; TRM: team resource management.

incidence of ACR remarkably decreased after the TRM program at five, five, one, and two cases in 2017 to 2020, respectively (Figure 2B). The three ACR during 2019 and 2020 were all of ET removal, with no CVC ACR. (Figure 2C, D)

#### 4. Discussion

Multifaceted and multidisciplinary intervention, such as that implemented through the TRM program, is fundamental for higher quality of clinical practices.<sup>7</sup> However, some studies have reported the ineffectiveness of such interventions.<sup>4,5</sup> This discrepancy is potentially due to regional differences in care practices and a lack of evidence-based intervention. In this study, we demonstrated a reliable and efficient step-by-step method to developing a TRM program. We drew attention to two critical points; the proposed intervention should, first, target intrasystemic risk factors and, second, be supported by relevant evidence. Used an example, ACR occurs due to many factors: from individual-level issues faced by patients and medical staff to systemic problems of medical undereducation, workforce availability, and interdisciplinary cooperation.<sup>8</sup> The direct adoption of the proposed intervention may not correct such intrasystemic and institutional problems, but an initial evaluation of an evidence-based intervention can prevent the waste of clinical resources. With accurate intervention (or modification) that heightens the attention of the critical care team as a whole, higher quality care can be provided. Our study was limited for lack of time- and environment-matched control group which biased risk assessments. A prospective design study is warranted to valid this preliminary data.

In conclusion, the development of an evidence-based TRM program to target intrasystemic risk factors effectively reduced ACR incidence in an ICU.

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#### Conflicts of interest

All authors declare no conflicts of interest.

#### References

- Kohn LT, Corrigan JM, Donaldson MS, eds. *To Err is Human: Building a Safer Health System*. Washington, USA: National Academies Press; 2000.
- Chen CM, Chan KS, Fong Y, et al. Age is an important predictor of failed unplanned extubation. *Int J Gerontol*. 2010;4:120–129.
- Sundarajan K, Wills S, Chacko B, et al. Impact of delirium and sutureless securement on accidental vascular catheter removal in the ICU. *Anaesth Intensive Care*. 2014;42:473–479.
- Mansouri P, Javadpour S, Zand F, et al. Implementation of a protocol for integrated management of pain, agitation, and delirium can improve clinical outcomes in the intensive care unit: a randomized clinical trial. *J Crit Care*. 2013;28:918–922.
- da Silva PS, Fonseca MC. Unplanned endotracheal extubations in the intensive care unit: systematic review, critical appraisal, and evidence-based recommendations. *Anesth Analg*. 2012;114:1003–1014.
- Richards-Belle A, Canter RR, Power GS, et al. National survey and point prevalence study of sedation practice in UK critical care. *Crit Care*. 2016; 20:355.
- Buljac-Samardzic M, Doekhie KD, van Wijngaarden JDH. Interventions to improve team effectiveness within health care: a systematic review of the past decade. *Hum Resour Health*. 2020;18:2.
- Galazzi A, Adamini I, Consonni D, et al. Accidental removal of devices in intensive care unit: An eight-year observational study. *Intensive Crit Care Nurs*. 2019;54:34–38.