Impact of nursing experience on cancellation of light sedation for mechanically ventilated patients in a setting of 1 : 2 nurse-patient ratio

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Abstract

Background: Caring for lightly sedated intubated patients increases caregiver workload. Therefore, providing light sedation to intubated patients may depend on nursing experience. We retrospectively investigated the association between conversion from light to deep sedation and nursing experience in intensive care units (ICUs) with a 1 : 2 nurse-to-patient ratio.

Methods: It was a historical cohort study performed in ICUs in a university hospital. One hundred and eighty-four patients requiring more than 72 hours of mechanical ventilation after ICU admission were analyzed. To avoid channeling bias, propensity score analysis was used to generate a set of matched cases (managed by trainee nurses) and controls (managed by experienced nurses), yielding 72 matched patient pairs. Primary (change from light to deep sedation) and secondary outcomes (sedation level after light sedation cancelation, ICU stay, and intubation duration) were compared.

Results: Conversion from light to deep sedation was equally preferred by trainee nurses, with conversion rates of > 70% regardless of matching procedure ($P = 0.663$). Deeper sedation was preferred by experienced nurses ($P = 0.025$). Management by experienced nurses significantly prolonged ICU stay (16.3 vs. 21.4, $P = 0.033$). Additional multivariable logistic regression revealed that visual disturbance (OR [95% CI] = 4.3 [1.4–13.3], $P = 0.012$), Richmond Agitation-Sedation Scale (RASS) (OR [95% CI] = 2.2 [1.7–2.9], $P < 0.0001$), and dexmedetomidine dose 48 h post-ICU admission (OR [95% CI] = 0.81 [0.69–0.96], $P = 0.016$) were independently associated with giving up light sedation.

Conclusions: Conversion from light to deep sedation was preferred in > 70% of mechanically ventilated patients in ICUs with a 1 : 2 nurse-to-patient ratio. Rates of sedation level changes for managing mechanically ventilated patients were similar between trainee and experienced nurses. However, experienced nurses preferred significantly deeper sedation than trainee nurses.

Key words: conscious sedation, intensive care units, clinical competence, personnel staffing and scheduling.

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In the past decades, evidence has shown that a lighter sedation strategy has beneficial effects for mechanically ventilated patients in intensive care settings [1–4]. Sedation protocols have previously been used successfully in mechanically ventilated patients [5], which were specifically designed for implementation by non-physician caregivers, who can quickly access patients depending on the situation [5]. However, it is more difficult to look after a slightly sedated intubated patient compared with a heavily sedated patient, because caring for lightly sedated patients depends more on nursing experience and requires increased caregiver workload [6, 7]. It is also difficult to provide light sedation to mechanically ventilated patients in ICUs with a manpower shortage. In such a case, it may be more likely that success in providing light sedation to intubated patients depends on nursing experience.

A nurse-implemented light sedation protocol for intubated patients has also been used in our institute. However, conversion from a light to a deep sedation protocol often happens. It is necessary to clarify the reasons for increasing the depth of sedation because this could result in worse outcomes [1–4].

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We hypothesized that nursing experience could be one of the contributing factors of such transition. As mentioned earlier, caring for lightly sedated patients can increase caregiver workload. Thus, this conversion may depend on nursing experience – less experienced caregivers tend to have less performance capacity against an increased workload, especially in an ICU with a manpower shortage. This retrospective study investigated whether conversion from light to deep sedation can be associated with nursing experience in ICUs with a nurse-to-patient ratio of 1 : 2.

METHODS

Ethics consideration

This observational cohort study was approved by the Ethics Committee of Nara Medical University Hospital (Kashihara, Japan; study number 1111). Written informed consent was waived by the Institutional Review Board.

Patient treatment

In this study, inclusion criteria included patients who were admitted to the ICU for mechanical ventilation for 72 hours or more and those who were over 20 years of age. The following were the exclusion criteria: (1) patients requiring immobilization with deep sedation for a certain period for surgical procedural reasons (e.g., postoperative management for specific procedures, especially reconstruction with microvascular anastomosis) and (2) patients admitted to the ICU after a cardiac arrest or cerebrovascular or traumatic brain injury. In a general ICU, a certified intensivist who supervised the ICU team, including intensive care nurses and a surgical or anesthesia resident, was readily available. The nurse-to-patient ratio was 1 : 2. After admission, rocuronium (1.0–2.0 mg kg^{-1}) and midazolam (0.1–0.2 mg kg^{-1}) were used to secure the airway with a tracheal tube and to initiate sedation. Patients under mechanical ventilation were sedated according to the needs resulting from their pathological condition. Sedation status was usually maintained at a deep level (the Richmond Agitation-Sedation Scale [RASS] –3 or –4) [8] during the first 24 hours after ICU admission even with additional small doses of analgosedatives probably due to residual effects of initial muscle relaxants and because of patients' clinical condition. Initially, patients were sedated with propofol (0.5–2.0 mg kg^{-1} h^{-1}), fentanyl (0.1–0.3 μg kg^{-1} h^{-1}), and dexmedetomidine (0.1–0.4 μg kg^{-1} h^{-1}) titrated to maintain appropriate depth of sedation. After the patient's condition was controlled and the therapeutic plan had been established, light sedation (RASS 0 to –1) was introduced, and the aim was achieved within 48 hours after ICU admission. However, some patients got agitated (RASS ≥ +2) only with small doses of analgosedatives. In such cases, attending nurses attempted to maintain light sedation according to their experience including adjusting pharmacotherapy; however, if they had difficulty maintaining light sedation, conversion from light to deep sedation was performed (RASS –2 to –4). RASS was recorded at least every 2 or 3 hours. Combined agents were used for analgosedation because the new guidelines support the use of multimodal pharmacotherapy to spare/minimize opioid and sedative use [9]. The attending nurses had completed a simulation-based training course in sedation for mechanically ventilated patients and have passed a practical exam in sedation management. Briefly, a protocol-based sedation concerning of pre-emptive analgesia was provided by trainee nurses (a nurse in step I or II of the 4-level clinical ladder for Japanese critical care nurses) or experienced nurses (a nurse in step III or IV) – each step approval is based on the evaluation of clinical performance, nurse performance in the group, research and educational task performance, and nursing ethics [10]. Noradrenaline and/or dobutamine were administered to keep the mean blood pressure at > 70 mm Hg depending on the indications. Decisions about weaning from mechanical ventilation were based on the daily assessment of attending physicians, wherein a spontaneous breathing trial was performed in patients under light sedation. Patients who demonstrated unassisted breathing for 1 hour indicated a successful breathing trial, and sedation was subsequently terminated and patients' trachea was extubated. Otherwise, mechanical ventilation was restarted. Patients were discharged from the ICU after being successfully weaned from mechanical ventilation based on the attending physician's discretion.

Data handling

Data of 3897 patients admitted to the ICU from June 2012 and December 2015 were reviewed. The exclusion criteria for the present study were (Figure 1): (1) nonintubated patients (n = 2979), (2) patients who underwent mechanical ventilation for less than 72 hours (n = 597), (3) patients < 20 years of age (n = 35), (4) patients with cardiac arrest and cerebrovascular or traumatic brain injury (n = 82), (5) patients requiring immobilization with deep sedation for a certain period for surgical reasons (n = 9), (6) those who did not require analgosedatives (n = 9), and (7) patients with missing data sets or no records (n = 2). Hence, only 184 patients were included in this study.

Statistical analysis

Continuous variables are presented as mean and standard deviation if normally distributed or as median and interquartile range if nonparametric. Categorical variables are presented as the number of patients and frequency (%). There is a growing interest in the use of propensity score-based methods in observational studies to estimate treatment effects. The propensity score is defined as the conditional probability of assigning a subject to a particular treatment protocol given a vector of measured covariates [11, 12]. To minimize the selection bias on outcomes, propensity score matching for clinical characteristics was used to reduce distortion by confounding factors. A set of matched cases (management by trainees, more than 50% being trainee nurses) and controls (management by experienced nurses, more than 50% being experienced nurses) was generated using the propensity score analysis. As a result, in the trainee group approximately 70% were trainee nurses while in the experienced group approximately 70% were experienced nurses. This was because of changing ratios of trainee-to-experienced nurses in the nursing educational system. The propensity score matching shows that 40 patients were excluded from the analysis. A propensity score was generated for each patient from a multivariable logistic regression model based on the covariates using data from the patients' charts as independent variables, with treatment type (management by trainees vs. experienced nurses) as a binary dependent variable.

The registered variables, including age, sex, height, body mass, present illness for the reason of ICU admission (cardiac, respiratory, others), comorbidity (alcohol use, dementia, diabetes mellitus, hemodialysis, hepatic failure, and hypertension), visual disturbance, hearing disturbance, communication disorder, sequential organ failure assessment (SOFA) score and lactate level at ICU admission, and RASS and analgosedative doses 48 hours after ICU admission, were included as potential confounders. A review of statistical research on propensity score development suggested that a structured iterative approach be used to refine this model, with the goal of achieving covariate balance between the matched pairs [11], measured using the standardized difference, where an absolute difference of > 0.1 was taken as a meaningful covariate imbalance [13]. Using the logit estimated from the log odds of the propensity score of each patient, each selected case with controls who had the nearest estimated logit value by 1 : 1 matching was matched. This procedure yielded 72 patients managed by trainees and propensity matched to 72 patients managed by experienced nurses. For statistical

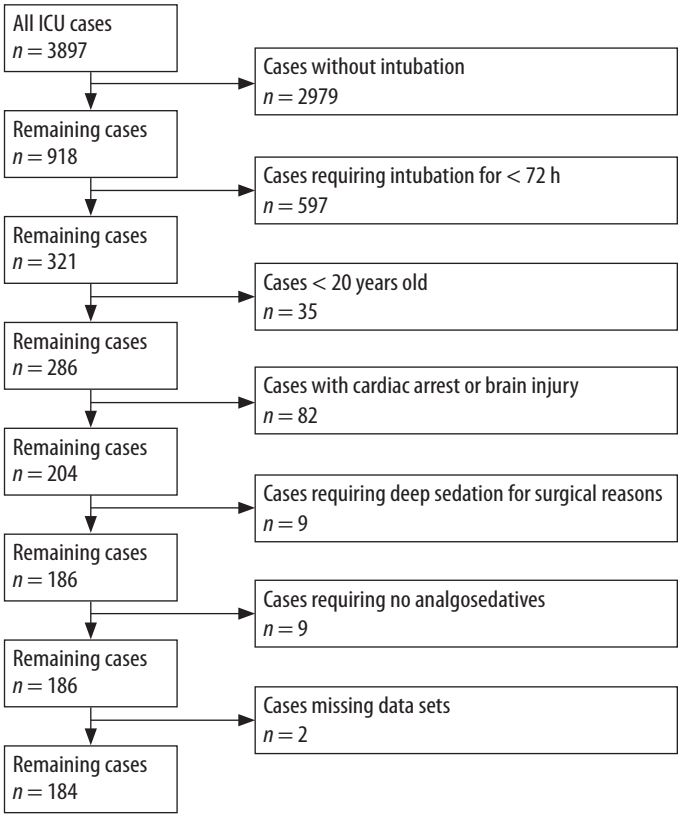

FIGURE 1. Flowchart of study population

inference, methods that account for the matched nature of the samples were used. For the overall incident rate, the Cochran-Mantel-Haenszel test, stratified on the matched pair, was used to estimate the odds ratio and 95% confidence interval (CI) of incidence of cancelation of light sedation (trainees vs. experienced nurses). Cancelation of light sedation (increasing the depth of sedation) was defined as reintroduction of lower RASS than the value noted 48 hours after ICU admission by increasing the analgosedative dose after 48 hours of ICU stay. The Cochran-Mantel-Haenszel test was used to compare secondary outcomes, such as in-hospital mortality, failure rate of weaning from mechanical ventilation, incidence of delirium, and requirement of physical restraint. Paired *t*-test was used for the matched pair comparisons of RASS after cancelation of light sedation, which was defined as the first recorded RASS after cancelation and 72 hours after ICU admission in case of no cancelation, days to successful extubation, and days in the ICU. In the unmatched population, Fisher's exact test and an unpaired *t*-test were used. An additional multivariate logistic analysis was conducted in the entire cohort (184 patients) with the conversion from light to deep sedation as the dependent variable and other covariates including management by trainees or experienced nurses as independent variables to confirm whether nurse's

experience is significantly associated with the risk of conversion from light to deep sedation. Univariate analysis was used to identify factors associated with cancelation of light sedation. Candidate factors having a significant univariate association ($P < 0.15$) with cancelation of light sedation were used to perform multivariable logistic regression analysis by forced-entry methods. All candidate variables were entered in the initial model and presented as adjusted odds ratios with 95% CI. Interactions between variables were systematically searched, and collinearity was considered for r or rho > 0.8 using the Pearson or Spearman coefficient matrix correlation, respectively. Discrimination of the final model for cancelation of light sedation was assessed using the likelihood ratio test. The Hosmer-Lemeshow statistic was used to test the calibration of the model.

Sample size calculation

To calculate a post hoc sample size, an 80% and a 30% incidence of cancelation of light sedation by management of trainees and experienced nurses, respectively, was arbitrarily assumed. In each group, 23 patients were required to provide 90% power with a type I error probability of 0.05. Thus, the sample size was sufficient to detect a difference in outcome. Analyses were computed using R (version 3.0.3, R Foundation for Statistical Computing, Vienna, Austria). A P-value of < 0.05 was considered statistically significant.

RESULTS

The clinical characteristics of the two matched groups extracted by propensity analysis are presented in Table 1 ($n = 72$ each). Before matching, covariates were not statistically different between groups; however, several variables, including age, sex, height, fentanyl dose and RASS 48 hours after admission, and lactate level, were not well balanced before matching (absolute difference > 0.1). After matching, covariates were well balanced, except for body mass and present illness for the reason of ICU admission. Especially, RASS 48 hours after ICU admission, which may be the most important factor, was balanced after matching.

Patient outcomes are summarized in Table 2. The change from light to deep sedation was equally preferred by trainee nurses, with conversion rates of over 70% regardless of matching procedure. Significantly deeper sedation was preferred by experienced nurses in managing patients. Physical restraint was required in around 50% of patients in both groups. The failure rate of weaning from mechanical ventilation was significantly higher in patients managed by experienced nurses than trainee nurses before matching; however, these rates became similar after matching. The tendency of worse outcome was observed in patients managed by experienced nurses, especially a significantly prolonged ICU stay, with an overall in-hospital mortality of more than 30%. However, in-hospital mortality did not differ between groups before and after matching.

Multivariable logistic regression analysis by forced-entry methods was performed with the following candidate variables: visual disturbance, diabetes mellitus, present illness for the reason for ICU admission, RASS 48 hours after ICU admission, dexmedetomidine and propofol doses 48 hours after ICU admission, and management by trainee nurses. It was found that visual disturbance, RASS 48 hours after ICU admission, and dexmedetomidine dose 48 hours after ICU admission were independently associated with giving up light sedation and transition to deep sedation (Table 3). However, management by trainee nurses was not associated with cancelation of light sedation. Using the likelihood ratio test, discrimination of the final model was found to be significant ($P < 0.0001$). Furthermore, the Hosmer-Lemeshow statistic did not reject a logistic regression model fit ($P = 0.092$). The explanatory model based on these variables had an area under the receiver operating characteristic (ROC) curve of 0.894 (95% CI: 0.840–0.934). Post hoc power calculations were performed for this forced-entry multivariate logistic regression model using seven variables. Standard methods were used to estimate the sample size for multivariate logistic regression, with at least ten outcomes needed for each independent variable [14]. With a 73.4% (135/184) incidence of increasing the depth of sedation in the study population, 95 patients were required to appropriately perform multivariate logistic regression. This demonstrates that the sample sizes were sufficient to build the models.

DISCUSSION

The more than 30% in-hospital mortality of participants was probably because of the severity of patient illness. Considering that an initial SOFA score of 8–9 could lead to mortality of around 30%, it can be assessed that caregivers provided appropriate care and therapy based on the standard practice [15]. During the light-sedation protocol, conversion from light sedation to deep sedation occurred in over 70% of patients. In contrast to the study's hypothesis, this conversion was performed equally in cases managed by trainee and experienced nurses. Interestingly, deeper sedation was preferred among experienced nurses once light sedation was canceled. Finally, prolonged ICU stay and prolonged in-

TABLE 1. Baseline patients' characteristics

Factor	Unmatched Trainee nurses ($n = 74$)	Experienced nurses ($n = 110$)	*P* value	Absolute difference	Matched Trainee nurses ($n = 72$)	Experienced nurses ($n = 72$)	*P* value	Absolute difference
Age (year)	70.4 (11.1)	68.9 (13.5)	0.443	0.12	70.3 (11.2)	69.0 (13.0)	0.551	0.1
Sex (Male/Female)	40/34	73/37	0.122	0.11	40/34	41/33	1	0
Body mass (kg)	57.1 (14.2)	57.8 (13.9)	0.744	0.05	57.5 (14.8)	55.2 (14.7)	0.342	0.16
Height (cm)	156 (10)	159 (8)	0.063	0.34	157 (10)	157 (8)	0.881	0.08
Present illness for the reason of ICU admission Cardiac/Respiratory/Others	51/9/14	71/18/21	0.733	0.06	49/9/14	46/15/11	0.354	0.12
Co-morbidity								
Alcohol use	1/73	3/107	0.65	0.01	1/71	1/71	1	0
Dementia	2/72	1/109	0.566	0.03	2/70	1/71	1	0
Diabetes mellitus	21/53	30/80	0.868	0	20/52	21/51	1	0
Dialysis	9/65	11/99	0.638	0.02	9/63	7/65	0.792	0.02
Hepatic failure	0/74	4/106	0.15	0.09	0/72	3/69	0.245	0.1
Hypertension	47/27	70/40	1	0	46/26	46/26	1	0
Visual disturbance	20/54	26/84	0.607	0.03	20/52	19/53	1	0
Hearing disturbance	12/62	18/92	1	0	11/61	14/58	0.661	0.04
Communication disorder	23/51	45/65	0.213	0.09	22/50	25/47	0.722	0.03
RASS 48 hours after ICU admission	1 (–1 to 1)	1 (–3 to 1)	0.182	0.3	1 (–1 to 1)	1 (–1 to 2)	0.391	0.03
Analgosedatives 48 hours after ICU admission								
Fentanyl (μg h^{-1})	24 (32.5)	20.5 (24)	0.392	0.13	21.0 (27)	21.5 (25.5)	0.95	0.01
Dexmedetomidine (μg h^{-1})	14 (11.2)	13.6 (12.4)	0.74	0.03	14.0 (11.6)	13.8 (12.4)	0.925	0.02
Propofol (mg h^{-1})	11.3 (38.2)	11.5 (29.9)	0.962	0.01	11.4 (38.8)	9.5 (23.9)	0.721	0.06
SOFA score at ICU admission	9 (7 to 11)	9 (6 to 11)	0.678	0.08	9 (7 to 11)	9 (6 to 11)	0.747	0.08
Lactate (mmol L^{-1})	3.6 (3.4)	4.0 (3.7)	0.487	0.11	3.6 (3.5)	3.8 (3.4)	0.684	0.07

BMI – body mass index, ICU – intensive care unit, RASS – Richmond Agitation-Sedation Scale, SOFA – sequential organ failure assessment

TABLE 2. Patient outcomes

Unmatched	Trainee nurses ($n = 74$)	Experienced nurses ($n = 110$)	Measure of effect (95% CI)	*P* value
Cancellation of light sedation (%)	56 (76)	79 (72)	OR, 122 (0.59–2.56)	0.612
RASS after cancellation of light sedation	–2 (–4 to –1)	–3 (–4 to –2)	Mean difference, 0.62 (0.18–1.06)	0.010
Requirement of physical restraint (%)	38 (51)	55 (50)	OR, 1.06 (0.56–1.99)	0.881
In-hospital mortality (%)	22 (30)	36 (33)	OR, 0.87 (0.43–1.72)	0.747
Incidence of delirium (%)	12 (16)	20 (18)	OR, 0.87 (0.36–2.03)	0.844
Failure rate of weaning from mechanical ventilation (%)	6 (8.1)	22 (20)	OR, 0.44 (0.14–1.44)	0.036
Days to successful extubation (SD)	5.6 (4.1)	6.6 (3.7)	Mean difference, 1.1 (–0.1 to 2.2)	0.065
Days in ICU (SD)	11.7 (9.0)	19.3 (33.7)	Mean difference, 7.6 (–0.3 to 15.5)	0.061
Matched	**Trainee nurses ($n = 72$)**	**Experienced nurses ($n = 72$)**	**Measure of effect (95% CI)**	***P* value**
Cancellation of light sedation (%)	54 (75)	57 (79)	OR, 0.75 (0.32–1.78)	0.663
RASS after cancellation of light sedation	–3 (–4 to –1)	–3 (–4 to –2)	Mean difference, 0.64 (0.09–1.19)	0.025
Requirement of physical restraint (%)	37 (51)	40 (56)	OR, 0.88 (0.49–1.57)	0.766
In-hospital mortality (%)	22 (31)	23 (32)	OR, 0.94 (0.46–1.90)	1
Incidence of delirium (%)	11 (15)	17 (24)	OR, 0.54 (0.21–1.35)	0.264
Failure rate of weaning from mechanical ventilation (%)	6 (8.3)	13 (18)	OR, 0.42 (0.15–1.18)	0.146
Days to successful extubation (SD)	6.1 (3.9)	6.7 (3.6)	Mean difference, –1.1 (–2.4 to 0.2)	0.083
Days in ICU (SD)	16.3 (28.6)	21.4 (39.1)	Mean difference, –10.2 (–19.6 to –0.8)	0.033

OR – odds ratio, 95% CI – 95% confidence interval, SD – standard deviation, ICU – intensive care unit

TABLE 3. Results of multivariable logistic regression analyses for cancellation of light sedation

	Odds ratio	95% CI	*P* value
Visual disturbance	4.285	1.384–13.266	0.012
Diabetes mellitus	0.439	0.178–1.085	0.075
Present illness at ICU admission			
Respiratory*	1.039	0.273–3.953	0.955
Others*	0.868	0.274–2.749	0.810
RASS 48 hours after ICU admission	2.221	1.724–2.862	< 0.0001
Dexmedetomidine dose 48 hours after ICU admission (μg h-1)	0.816	0.692–0.963	0.016
Propofol dose 48 hours after ICU admission (mg h-1)	0.950	0.851–1.061	0.362
Management by trainee nurses	0.560	0.223– to 1.405	0.217

*Cardiac disease is defined as the reference level.
ICU – intensive care unit, RASS – Richmond Agitation-Sedation Scale

tubation time were observed in patients managed by experienced nurses. Cancelation of light sedation was not associated with nurse's experience, but was significantly associated with visual disturbance, RASS, and dexmedetomidine dose 48 hours after ICU admission.

The cancelation of light sedation in over 70% of patients is possibly because RASS was not appropriately maintained at the targeting sedation level in the sedation protocol, which was supposed to be 0 to –1; however, the median RASS 48 hours after ICU admission was 1. It was difficult to maintain sedation at appropriate level 48 hours after ICU admission, because patients were in a relatively critical condition (the median SOFA was 9) that fluctuated to a certain degree even after it was more or less stabilized at a certain level. The rate of intentional conversion from light to deep sedation has not been reported; however, a meta-analysis of sedation studies in the ICU has demonstrated that there is a high incidence of undesired deep or over-sedation – up to 40% to 60% of cases [16]. Thus, our high rate of the cancelation of light sedation may be understood. In addition, a nurse-to-patient ratio of 1 : 2 in the ICU, indicating a manpower shortage, might have affected the main outcome. It was suggested that a light- or no-sedation strategy with a 1 : 2 nurse-to-patient ratio can be challenging in the management of mechanically ventilated patients [17]. However, a 1 : 1 nurse-to-patient ratio may be advantageous to experienced nurses in patient care, resulting in different outcomes.

Although this is not the primary outcome, experienced nurses preferred deeper sedation once light sedation was canceled, especially in an ICU with a relative manpower shortage. They work as a consultant and a caregiver according to the clinical ladder for Japanese critical care nurses [9], leading

to a heavier workload than trainees. As mentioned above, caring for lightly sedated patients has been reported to increase workload [6, 7]. Therefore, experienced nurses preferred deeper sedation to perform more tasks. As presented in the results, adverse outcomes, such as prolonged ICU stay and prolonged intubation time period, were observed in patients managed by experienced nurses. These results may be reasonable because light sedation, daily sedation interruption, or no sedation have been reported to decrease ICU stay and duration of mechanical ventilation [1–3]. However, this study was not designed to detect these differences between management by trainees and experienced nurses. Besides, the direct decision for weaning from mechanical ventilation and ICU discharge was made by attending physicians. Future investigation regarding the effect of nursing experience on ICU stay or intubation period may be needed.

Cancelation of light sedation was not associated with nursing experience, as confirmed by the additional multivariate logistic analysis in the entire cohort. Incidentally, the logistic model for cancelation of light sedation revealed that visual disturbance, RASS 48 hours after ICU admission, and dexmedetomidine dose 48 hours after ICU admission were independently associated with cancelation of light sedation. It was difficult to titrate sedation for patients with visual disturbances because they were susceptible to delirium [18]. A high RASS score during a light-sedation protocol in a manpower shortage situation was sufficient evidence for changing from light to deep sedation. This indicates difficulty in maintaining an adequate level of sedation in patients with a relatively unstable status during an early-phase ICU stay, which requires a highly complex level of knowledge and skills needed to safely manage critically ill sedated intubated patients [19]. Dexmedetomidine was reported to improve patient communication with the nursing staff compared with propofol or midazolam [20]. Sedation management with higher doses of dexmedetomidine might have lowered cancelation of the light-sedation protocol.

We hypothesized that nursing experience could be one of the contributing factors of changing from light to deep sedation. However, such action was made equally in cases managed by trainees and experienced nurses. As mentioned before, a nurse-to-patient ratio of 1 : 2 in the ICU in Japan might have affected the main outcome. Decision making in sedation management requires a highly complex level of knowledge and skills needed to safely manage critically ill sedated intubated patients [19]. In a setting of nurse-to-patient ratio of 1 : 1 in the ICU, experienced nurses burdened with a workload equal to trainees would have demonstrated more favorable outcomes. Otherwise, implementation of a light sedation protocol might be difficult to perform in a nurse-to-patient ratio of 1 : 2 in the Japanese ICU regardless of nursing experience.

Several limitations were considered in this study. To minimize the effect of selection bias on outcomes, propensity score matching for clinical characteristics was used to reduce distortion by confounding factors. However, in this retrospective study, unmeasured variables could still confound the results. Therefore, several variables that may have affected cancelation of light sedation could not be obtained. Furthermore, in propensity matching, all absolute differences for covariates did not completely reach a value < 0.1. Imbalance of the cohort because of the limited number of patients cannot be ruled out and could have affected the analysis. However, a 2-kg weight difference and a very small effect size (0.12) for present illness for the reason of ICU admission may be clinically negligible. Next, this study was conducted in Japan, where the length of hospital stay is relatively long [21]. Although a direct comparison of the length of ICU stay in various countries is not available, it is supposed that ICU stay in Japan might also be relatively long. The Japanese universal public insurance system is relatively generous to hospitalization. Therefore, hospitalization in Japan is usually determined not only by the patient's medical status but also his or her social background. This complexity may be managed better by experienced nurses, who have longer ICU experiences and consider social and ethical concerns more seriously. Therefore, results cannot be generalized in countries with shorter hospitalization time. Finally, a considerable number of patients were excluded from the study.

In conclusion, conversion from light to deep sedation was preferred in over 70% of mechanically ventilated patients in ICUs with a 1 : 2 nurse-to-patient ratio. There was no difference in the rate of cancelation of light sedation between trainees and experienced nurses in managing mechanically ventilated patients. However, experienced nurses preferred significantly deeper sedation compared to trainee nurses. Although it was not determined whether deeper sedation affected this outcome, patients managed by experienced nurses had a significantly prolonged ICU stay.

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