Predictors of Sleep Quality and Successful Weaning From Mechanical Ventilation Among Patients in Respiratory Care Centers

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Abstract

Background: Poor quality of sleep may result in more problems for patients who undergo weaning from mechanical ventilation because it could result in disabled muscle relaxation and affect the function of the respiratory muscles. Few studies have specifically investigated what factors contributed to quality of sleep and weaning outcomes.

Purpose: This study investigates the predictors of quality of sleep and successful weaning from mechanical ventilation in patients at respiratory care centers.

Methods: We used a cross-sectional design to recruit 94 patients who were in the process of weaning from ventilation at three respiratory care centers in a medical center in central Taiwan. A structured questionnaire was used to collect data. Disease severity during the first 24 hours after commencing the weaning process was assessed using the Acute Physiology and Chronic Health Evaluation II. Level of consciousness was evaluated using the Glasgow Coma Scale, and quality of sleep was measured using the Verran and SnyderYHalpern Sleep Scale. Stepwise multiple regression and logistic regression were used for multivariate analysis.

Results: Fifty-three (56.4%) of the 94 participants successfully completed the weaning process. Participants who successfully weaned within 72 hours were younger (p = .038), had a lower level of disease severity (p G .001), and had a better quality of sleep (p = .004) than their counterparts who failed to wean. Factors including disease severity (B = j1.32), current use of hypnotic drugs (B = j10.71), and having three-to-four coexisting chronic diseases (B = j9.91) contributed negatively to quality of sleep. Factors including level of consciousness (odds ratio[OR] = 1.64), quality of sleep (OR = 1.05), disease severity (OR =0.81), and alcohol consumption history (OR = 0.21) were found to significantly impact weaning success.

Conclusions/Implications for Practice: A strong relationship was identified between disease severity and quality of sleep. Both factors are significant predictors of successful weaning from mechanical ventilation. A better understanding of the related risk factors will help improve the care provided by nurses and medical personnel to patients undergoing the weaning process.

KEY WORDS: quality of sleep, weaning, mechanical ventilation, respiratory care center.

Introduction

Quality of sleep is an important indicator in patients undergoing weaning from mechanical ventilation (Tracy & Chlan, 2011). Patients who have sufficient sleep at night will be able to endure the weaning process, and this is considered important than the best therapy by medical personnel (Astle & Smith, 2007; Branson, 2012). Mechanical ventilation support is designed to help patients with respiratory failure maintain reasonable oxygenation and ventilation (Newmarch, 2006). The ultimate goal of the weaning training process is to enable patients to breathe spontaneously for over 72 hours with proper physical monitoring without the ventilator (Dries, McGonigal, Malian, Bor, & Sullivan, 2004). Once the cause of the respiratory failure has abated, patients should be weaned as soon as possible so they can quickly resume their spontaneous respiratory and physical function. For example, Boles et al. (2007) integrated statements of six international consensus conferences on weaning from mechanical ventilation and emphasized that prolong mechanical ventilator causes physical discomfort, increase risks of pneumonia and airway trauma, and costs of treatment and care.

Mechanically ventilated patients possibly suffer obviously fragmented sleep due to the ventilation-related distress, such as discomfort of endotracheal tube and ventilator use (Patel, Chipman, Carlin, & Shade, 2008). As a result, impaired sleep-related outcomes such as those measured by subjective quality of sleep should not be ignored in hospitalized patients (Chen, Lin, Tzeng, & Hsu, 2009). Ideally, a complete sleep cycle is 90 minutes for a normal adult who requires 6-8 hours of sleep time every night (Campbell & Murphy 2007). However, intensive care patients have a frequent change in the sleep cycle, waking up every 20 minutes. The intubation period for sleep in these patients is prolonged, and sleeping quality is lowered. It is difficult for patients to achieve deep sleep and make up for their loss of sleep. Some studies have shown that only 50%-60% of the patients in the unit can maintain their nighttime sleep, but this does not mean that they have completed sleep cycles (Hardin, Seyal, Stewart, & Bonekat, 2006; Honkus, 2003).

Weaning patients from a mechanical ventilator is a time-consuming and complex managed process (Goodman, 2006)that is a unique experience for each patient. Before starting weaning, patients should have an appropriate physical and psychological readiness and show overall progress (Goodman, 2006), such as an acceptable physical condition and adequate sleep. A review of the literature on sleep quality and weaning outcomes from a mechanical ventilator showed that physiological, psychological and environmental factors impacted on sleep quality and might also affect the weaning outcomes. Physiologically, various studies have investigated the relationship between sleep quality and several relevant variables, including age (Reid et al. 2006; Yao, Yu, Cheng, & Chen, 2008), gender (Machodo, Barreto, Passor, & Lima-Costa, 2006; Hsu and Li 2005), and long-term condition or number of existing chronic illnesses (Wu , Su , Fang, & Chang, 2012; Huang & Tsai, 2001). For instance, Foley, Ancoli-Israel, Patricia, & Walsh (2004) found that for 1,506 participants aged 55-84 years in the United States, more than 40% with four or more chronic illnesses rated their quality of sleep as fair or poor. By contrast, only 10% of participants who did not have a chronic illness reported their quality of sleep as fair or poor. Other studies indicated that multiple factors such as illness severity, albumin level, time to tracheostomy, sum of chronic comorbidities and alcohol might affect weaning outcomes (Diaz-Abad, Verceles, Brown & Scharf, 2012; Klatsky, 2004, Wu et al., 2009). It is very important to consider whether illness symptoms in patients continue to improve, whether they have optimum physical fitness and sufficient nutrition to take on the weaning process, and whether their sleeping habits and patterns will affect the progress of weaning (Goodman, 2006, Wu, Kao, Hsu, Hsieh, & Tsai, 2009). In addition, disease severity and use of hypnotic drugs may affect quality of sleep for patients undergoing the weaning process (Collop, Adkins & Phillips, 2004; Dines-Kalinowski, 2002; Frisk & Nordström, 2003). Research also indicated that psychological factors were related to patients' physiological conditions during the weaning process (Chen, Lin, Tzeng, & Hsu, 2009). For example, Twibell, Siela, & Mahmoodi (2003) emphasized that patients tend to worry about successful weaning, especially when they experienced physiological condition change, such as hemodynamic instability or metabolic imbalance. Chen and Ma (2004) found that patients who were unable to cope with the physiological symptoms resulting from weaning had a lower level of comfort. While factors such as light and noise might affect quality of sleep for patients residing in hospital (Walder, Francioli, Meyer, Lancon, & Romand, 2000, Collop et al. 2004, Morgan and Closs 1999), no studies were found showng that environment factors directly influenced weaning outcomes.

Few studies had been conducted to explore the relationship between quality of sleep and weaning outcomes in Taiwan. The overall aim of this study was to understand the associations between patients' demographics, disease distribution, sleep quality and weaning outcomes, and identify the predictors that contributed to successful weaning and quality of sleep.

Methods

Design and Sample

We adopted a cross-sectional design with consecutive sampling to recruit participants in three RCCs with a total of 64 beds in a medical center in Taiwan. Only patients who met the eligibility requirements and provided written informed consent participated in the study and all those meeting the eligibility criteria were approached. The inclusion criteria were: patients who (a) were aged 17 or older requiring respiratory integrated delivery system by government; (b) were in the process of being weaned from the ventilator; (c) were conscious and able to communicate in Mandarin Chinese or Taiwanese, and (d) had a "low risk" health status as determined by attending physicians, that is, a heartbeat rate between 60 and 120 times per minute, blood pressure between 90-150/50-100 mmHg, a respiratory frequency lower than 25 times per minute with a stable respiratory pattern, SPO2 greater than 90%, and oxygen use concentration lower than 50%. The exclusion criteria were patients with: (a) brain or spinal nerve damage; (b) central nervous system lesions; or (c) mental impairment. Seventeen was the minimum age for a patient to use the mechanical ventilator, but the youngest participant in the study was aged 28, and all participants were able to give their own consent.

An average of 12 patients had been weaned from mechanical ventilation at the RCCs every month. It was anticipated that within the funded time frame of the study (10 months), it would be possible to recruit 90-100 eligible patients. This would be compatible with the number needed to use multiple regression analysis to predict quality of sleep for with up to six independent predictors, assuming 5% significance, 80% power and moderate effect sizes (Miles & Shevlin, 2001, Tabachnick & Fidell, 2001). A hundred eligible patients agreed to participate in this study, but six were later excluded because of fatigue, a heartbeat over 130 times per minute, a breathing rate over 35 times per minute or going back onto the ventilator due to infection. Data were collected from a total of 94 patients.

Measures

All participants completed a four-part structured questionnaire by interview. The first two parts covered demographic and clinical information, including age, gender, number of co-existing chronic illnesses, history of drinking alcohol, use of hypnotic drugs in the past and present, tracheotomy surgery, albumin, and days of ventilator use. Weaning outcome was categorized as dichotomous (yes/no) for data analysis.

The APACHE II and the GCS

The third part of the questionnaire contained the Acute Physiology and Chronic Health Evaluation II (APACHE II). This was used to record disease severity during the first 24 hours after participants had started weaning, using a total of 14 items with scores between 0 and 71 (Kahn et al., 1998). Subscales included: (1) the 12-item acute physiology score (APS), which included the Glasgow Coma Scale (GCS), scored from 0 to 60, the higher the score, the less normal the physiological value; (2) age, scored from 0 to 6 according to age group, the higher the age, the higher the score; and (3) chronic health evaluation (CHE), 1 item, where patients with defined chronic illness and having undergone an emergency surgery scored 5, those having undergone optional surgery scored 2, and others scoring 0. For this study, Cronbach's α for the full scale was calculated at 0.81.

The GCS used within the APACHE II APS score was also considered separately. Its purpose is to measure the depth and duration of impaired consciousness and coma in patients based on change in consciousness (Teasdale & Jennett, 1974). The scale, which can be recorded by doctors and nursing staff, has been generally applied in critical care units in hospitals. It includes three items: motor response (scored 1-6), verbal response (scored 1-5) and eyes opening (scored 1-4). Total scores range from 3 to 15, higher scores indicating greater consciousness. For this study, Cronbach´s α for the full GCS was 0.80.

Verran and Snyder-Halpernu (VSH) Sleep Scale

The fourth part of the questionnaire contained the Verran and Snyder-Halpern (VSH) Sleep

Scale. This is a self-report questionnaire which subjectively evaluates the patients' satisfaction with their perceived sleep in health institutions (Snyder-Halpern & Verran, 1987). Originally, the VSH scale was specifically designed for hospitalised patients. Its main strength is that it is generally used to evaluate quality of sleep for patients in hospitals, such as intensive care patients, and not in the community. It was considered an appropriate tool for measuring quality of sleep in this study. The scale is a 100-millimetre horizontal visual analogue measurement. Contrasting descriptions of perceived feelings toward sleep are found at both ends of the scale. There is a total of 15 items (total scores: 1500), with the lowest score being 0 and the highest being 100. The subscale includes three major dimensions: sleep disturbance (eight items), effective sleep (four items), and supplementary sleep (three items). However, the VAS score can be normalised to correct for variation in subscale length, resulting in a score in the range 0–100, with higher scores meaning better sleep quality. The Chinese Version of the VSH Sleep Scale has high reliability and validity (Lin & Tsai, 2003). For this study, Cronbach´s α for the full scale was 0.89. Values for the subscales were 0.83 for sleep disturbance, 0.83 for effective sleep, and 0.85 for supplementary sleep.

Data collection

Data collection was conducted from from March to December 2009. Because participants were using a mechanical ventilator, data were collected through interview by the first author at the participant's bedside and from electronic records checked by a nurse with 7 years of clinical experience in critical care units. First, demographic and disease-related data were collected by the first author from participants as they started the weaning process. The nurse then collected the APACHE II scores within 24 hours from electronic medical records, checking the calculations made by clinical nurses for consistency. To minimize distress in participants during the weaning process, data from the VSH Sleep Scale were collected from participants by the first author 72 hours after the weaning process had begun. Although the VSH Sleep Scale was designed to be a self-administered questionnaire, it may also be completed by interview. Interviews were timed so as to not disturb treatment or visiting hours, but families were allowed to be present during the interview process in case participants required assistance from their relatives to answer questions.

Ethical consideration

The current study was approved by China Medical University Hospital Institutional Review Board (DMR-97-IRB-024). Data collection began only after a patient had consented to take part. Before obtaining written informed consent, researchers explained the purpose, method, and process of this study to patients and their families and stressed their right to withdraw at any time. They also clarified that participation in this study did not mean that patients would be treated differently in terms of therapy or care quality and all information from participants was treated as anonymous and confidential.

Statistical Analysis

Data were analyzed with SPSS™ Release 16.0 (SPSS Inc., 2008). Demographic characteristics, disease attributes and distributions of the study sample were summarized descriptively. Statistical tests were used to examine differences in demographic characteristics, disease attributes and VHS Sleep Scale scores between participants who had and had not successfully weaned within 72 hours: the independent t-test, the χ^2 test and the χ^2 test for trend were used when the variables were continuous, dichotomous/nominal and ordinal respectively. The independent t-test, one-way ANOVA, Pearson’s correlation and Spearman's correlation were used to examine relationships between demographic characteristics, disease attributes and VHS sleep scale scores. Stepwise logistic regression analysis was used to estimate models to predict the odds for the success of weaning from the ventilator; odds ratios, their confidence intervals, p-values, and the Nagelkerke pseudo-R-square were estimated. The Nagelkerke R-square is a generalized coefficient of determination, used a measure of the generalized variance explained in a logistic regression model, the equivalent of the coefficient of determination R-square in multiple regression (Nagelkerke, 1991). Finally, stepwise linear regression analysis was used to estimate models to predict sleep quality; unstandardized regression coefficients, their 95% confidence intervals, standardized regression coefficients, p-values and adjusted-R-square were estimated. As a guide to their likely statistical importance, variables were considered candidates for modeling when the p-value of their association with dependent variables, i.e. weaning outcomes and global quality of sleep, satisfied a conservative $p < .25$ (Hosmer and Lemeshow, 2000).

Results

Participant characteristics

The participants consisted of 45 males (47.9%) and 49 females (52.1%). The mean age of the 94 participants was 69.5 (SD 15.9, range = 28 - 85) years and 64 (68.1%) participants were aged over 65 years. Most were married, unemployed, educated at the high school or lower level, and lived with their families. The GCS mean scores was 13.7 (SD 1.5, range 11-15) in participants. On average, they spent 39.9 (SD 19.0) days on the ventilator.

Co-existing chronic illness

Eighty (85.1%) participants had at least one chronic illness and 62 (66.0%) had one or two diseases, with a mean of 1.9 (Table 1). Age and number of co-existing chronic illnesses were significantly correlated (Spearman's $\rho = 0.26$; $p = .015$).

Independent variables and weaning outcomes

There were 53 patients (56.4%) who successfully completed weaning from the mechanical ventilator within 72 hours, and 41 (43.6%) who had not. Age ($p = .038$), the GCS ($p = .005$) and the APACHE II ($p < .001$) showed a significant difference between groups. Those who were not weaned from the ventilator were older, were less conscious and had higher disease severity. The APACHE II subscale scores were also significantly worse among those not weaned: APS ($p = .043$), age score ($p = .042$) and chronic health score ($p = .002$).

VSH sleep scale and independent variables

Across the entire sample, the mean score for the VSH scale was 41.6 (SD 15.8). This represented a considerably lower value of quality of sleep than the midpoint on the 100 point VAS. There were different levels of association between independent variables and the VSH Sleep Scale and its subscales (Table 2). For the VSH Sleep Scale, the one with the highest significance was disease severity ($p < .001$). The others were hypnotic drugs under use ($p = .002$), hypnotic drugs used in the past ($p = .003$), amount of chronic illness ($p = .025$), and age ($p = .014$).

Sleep scale and weaning outcome

Comparison of the VSH scale and its subscale scores by weaning outcome showed that the weaned group had significantly higher scores for the total sleep scale, sleep disturbance scale and sleep effectiveness scale (all $p < .01$) (Table 3). The weaned group also had a slightly but not significantly higher score on the sleep supplementation scale ($p = .443$). Therefore in general, the sleep quality of the weaned group was higher than individuals in the non-weaned group.

Predictive factors of successful weaning

Variables entered in the multiple stepwise logistic regression model included age, number of co-existing chronic illnesses, history of drinking alcohol, albumin, days of ventilator use, the GCS, the APACHE II and the VHS scale based on the bivariate p-value at $p < .25$ (Hosmer & Lemeshow, 2000). For modeling, the number of chronic illnesses was converted into three levels as 0, 1-2, and 3-4 co-existing chronic illnesses. However, only four variables remained in the final model (Table 4). Adjusted for other variables in that model, the GCS, the APACHE II, VSH sleep scale, and history of drinking alcohol were significant predictors for successful weaning, with a Nagelkerke R-square of 41.1%. For each increase of one point in the GCS, the odds of successful weaning were multiplied by a factor of 1.644; when the APACHE II score increased by one point, the odds of successful weaning were multiplied by 0.81 (i.e. reduced by one-fifth); when the total sleep scale score increased by one point, the odds of successful weaning were multiplied by 1.015. This meant that when global quality of sleep improved in participants, successful weaning from mechanical ventilation was more likely. However, for those with a history of history alcohol, the odds of successful weaning were multiplied by a factor of 0.208 (i.e. reduced by four-fifths).

Predictive factors of quality of sleep

Variables entered in the stepwise linear regression model included age, number of co-existing chronic illnesses, hypnotic drugs used in the past, hypnotic drugs under use, albumin, disease severity (APACHE II), days of ventilator use, and the GCS, again based on the bivariate p-value at $p < .25$ (Hosmer & Lemeshow, 2000). The number of co-existing chronic illnesses was again converted into three levels. Only the APACHE II score, hypnotic drugs under use, and 3-4 chronic illnesses were included in the final model, with an adjusted R-square of 25.3% (Table 5). For each increase of one point in the disease severity score, the total quality of sleep decreased by 1.323; participants currently on hypnotic drugs scored 10.717 less than those not taking the drugs; and participants with 3-4 chronic illnesses scored 9.905 less than those with fewer than three chronic illnesses.

Discussion

The main purpose of this study was to understand predictors that contributed to quality of sleep for the successful weaning of patients from mechanical ventilation in Taiwan. Our study generated a number of important findings. Initially, 53 (56.4%) of the 94 participants who participated in the process of weaning from the ventilator succeeded within 72 hours. Our weaning rate was similar to results of other studies investigating the weaning rate in RCCs in Taiwan (48%-68%) (Shih, Lee, Liu, Chul, & Chen, 2011; Wu, et al. 2009). Our non-weaned rate of 43.6% was slightly higher than that in a review of the weaning rate in six other non-Taiwanese studies (26%-42%, mean 31.2%) (Boles, et al. 2007). In addition, the mean of age in present study were lower than another Taiwanese study by Wu et al. in 2009 (69.5 years versus 73.2 years), although the authors had not reported that ratio of older patients in their previous study. Furthermore, as 64 (68.1%) of the sample were aged 65 or over, 80 (85.1%) participants had chronic illnesses, with nearly two chronic illnesses on average per participant. These findings compare with those of other studies on chronic illnesses of the elderly (Chasens, Sereika, Weaver, & Umlauf, 2007; Wu et al., 2009).

We found that several factors appeared to predict the weaning outcome and quality of sleep. Age, level of consciousness, and disease severity differentiated between successful and failed weaning from the mechanical ventilator. The average age of weaned patients was less than that of non-weaned patients, confirming findings from two previous studies (Lone & Walsh, 2011; Wu et al., 2009). Patients in our study required a level of consciousness sufficient for them to agree to participate and complete the VSH. As a result, the GCS score was from 11 to 15 points. The consciousness level in the weaned group was higher than that in the non-weaned group, and the GCS was able to predict successful weaning (OR = 1.644). The result was similar to that of another study (Wu et al., 2009). Regarding disease severity, the weaning outcomes were compromised as a result of illness severity, which was also a strong predictor of successful weaning predictor (OR = 0.810). We found that the average APACHE II disease severity score for those successfully weaned from the ventilator was 7.9 points in this study, lower than the average 13 to 18 points found in other RCC-related studies (Chen et al., 2004; Wu et al., 2009). This may be because the APACHE II was measured at the beginning of the weaning process to ensure an acceptable tolerance in participants, while the measurement in other studies was on the day of admission to the RCC. In addition, it is noteworthy that only patients who were conscious and whose illness was stable were included into this study. However, our study supports previous studies in that disease severity in the weaned group was higher than in the non-weaned group. When a disease cannot be stabilized, it will delay the initial stage of weaning or prolong the duration of weaning, and resulting in a frequently interrupted weaning process. Consequently, patients with a higher degree of disease severity have more difficulty in successfully weaning from the ventilator (Lone & Walsh, 2011; Wu et al., 2009). In our study, disease severity was a key predictor of successful weaning. In addition, a history of drinking alcohol was another predictor of successful weaning in this study. A long-term history of drinking may cause cardiopulmonary hypertension, pulmonary alveolus damage, and oxygenation dysfunction (Klatsky, 2004). Patients with a drinking history may be difficult to wean from the mechanical ventilator.

We found that when it was considered on its own, there was a negative relationship between age and total quality of sleep, sleep disturbance, sleep effectiveness, and sleep supplementation. These findings support other sleep-related studies on aging, which show that the sleep cycle of elderly people undergo changes, such as: decreased total sleep time, increased time spent falling asleep at sleep onset, sleep fragmentation and daytime sleep, and that sleep efficiency is worse than in younger people (Kryger, Roth, & Dement, 2011). Poor quality of sleep not only occurs on older people who reside at home (Yao et al., 2008), it also happen in the hospitalized older patients (Shiung, Chang, Chou, & Chao, 2009), such as in weaning units (Chen et al., 2009). Theoretically, in older people, the first stage of the non-rapid eye movement (NREM) is prolonged and deep sleep will not persist into the third and fourth stages; the length of the rapid eye movement (REM) stage decreases in the older adults. Therefore, sleep tends to have shallower and shorter cycles, which results in interruptions in night-time sleep or dozing off too much in the day. Sleep quality will also become worse (Kryger et al., 2011; Campbell & Murphy, 2007).

Our study also shows that sleep quality will be compromised as a result of disease severity. When disease severity cannot be controlled, poor physical symptoms will follow, such as body pain and difficulty in breathing. This could delay the start time for sleep or shorten the continuation of sleep, resulting in frequently interrupted sleep. Having a larger number of chronic illnesses also interferes with quality of sleep. Our findings are consistent with a national survey that more than 40% of people who aged 55-84 years with more than 3-4 chronic illnesses in the US rated their quality of sleep as fair or poor (Foley et al., 2004).

The past and current use of hypnotic drugs were also strongly negatively associated with sleep quality. During the data collection period, medical personnel in the RCCs often heard patients complaining about not being able to sleep at night and asking for a sleeping pill. Frequently encountered situations included: 1) patients falling asleep right away but not being able to go back to sleep after waking up after 1-2 hours; 2) patients who could not fall asleep until later; 3) patients who continued to have problems falling asleep and who had to try a different hypnotic for a few days until they found the one that worked for them; and 4) patients living in a cycle of staying awake for two consecutive days and sleeping for another two consecutive days. We found that even when patients had taken a hypnotic drug, the quality of sleep did not appear to improve at all. Unlike a previous study (Pasero & McCaffery 2002), our study shows that using hypnotics yielded poorer sleep quality during the weaning stage.

When the predictors were considered together in a linear regression model, only disease severity, hypnotic drugs under current use and having 3-4 chronic illnesses were significant. The predictive abilities of age and the past use of hypnotic drugs did not appear to be important once the other variables were in the model.

We found that quality of sleep, measured using the VHS sleep scale, was significantly and positively associated with successful weaning from a mechanical ventilator, when considered on its own in bivariate analysis and in combination with other predictors in multivariate analysis (OR = 1.051). The mean VHS scores in the two groups were lower than 50 (45.9 in weaned vs 36.1 in not-weaned), but were similar to a mean of 40.31 in another sleep-related investigation in Taiwanese critical care units (Feng & Wang, 2007). Authors of a quality of sleep study of patients taking respiratory care commented that an incomplete deep sleep cycle would disable muscle relaxation, which in lighter cases would result in sore muscles and joint pains, and in extreme cases would lead to overall fatigue and affect the function of the respiratory muscles (Chen et al. 2009). The researchers pointed out the clinical significance of the relationship between sleep quality and successful weaning outcomes, emphasizing that only patients with a sufficient sleep will have the necessary energy for the weaning process.

For patients undergoing the weaning process, insufficient quality of sleep will have a negative effect on the weaning outcome.

Limitations of the study

There are a number of limitations to this study. Due to limited time, resources, and manpower, recruitment was restricted to patients in central Taiwan. Results may be generalized to groups with characteristics similar to the study sample, but generalization to other populations should be considered with caution. In addition, quality of sleep was measured using a questionnaire that was filled out on the morning of the fourth day after weaning training had commenced. This is a retrospective method and patients' responses may be subject to patient memory error or weaning success. Due to limited funding, only the sleep quality scale was used in the measurement of quality of sleep. If multiple evaluation methods with higher reliability had been used to analyze the quality of sleep of the patients, such as sleep monitors, study objectivity could be enhanced. Finally, only the use of hypnotic drugs was recorded and not other medications which many have been prescribed.

Conclusions/implications for practices

There are few studies that specifically investigate the association between quality of sleep and weaning from mechanical ventilation for patients and our study helps fill an important gap. We found a close relationship between quality of sleep and disease severity among patients in RCCs and we estimated their impact on successful weaning from mechanical ventilation. Initially, to reduce disease severity, clinical nurses need to provide appropriate quality health care to patients. They need to be better trained in the understanding of a successful weaning process and what key factors affect quality of sleep and weaning outcomes. Hospital managers should provide the appropriate nursing education. Further, clinical nurses need to be aware that poor quality of sleep is significantly associated with weaning outcomes. In addition to use of sleep medication, nurses can provide accessible non-pharmacological treatments, such as listening to relaxing music and providing massage, to improve sleep quality. Hypnotics are used in patients who are sleepless or to relieve respiratory tract distress and improve oxygenation, and we consider that they should continue to be administered. Clinical nurses and medical personnel must also evaluate the physical changes in patients and provide safe and effective non-hypnotic measures or hypnotics to help patients sleep and improve their sleep quality.

Future studies will be required to confirm the findings and establish a definitive cause and effect relationship. For example, it may be necessary to conduct a large-scale study to measure physical, psychological, pharmacological and environmental factors and their interactions. However, identifying the key factors that affect the success of weaning from a mechanical ventilator will be useful to the medical team in improving the care and management of these individuals.

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Table 1 Co-existing chronic illness in the sample (N = 94)

Variables	N	%
Number of chronic illnesses		
None	14	14.9
1-2	62	66.0
3-4	18	19.1
Type of chronic illness[a]		
Diabetes	35	37.2
Hypertension	34	36.2
Heart disease	21	22.3
Respiratory tract disease	19	20.2
Kidney disease	12	12.8
Stroke	3	3.2
Others (digestive system & immune system)	17	18.1

Notices: [a] Participants could have more than one.

Table 2.
Relationship of demographic characteristics and disease attributes with the VSH sleep scale (N = 94)

Variables	VHS	SDS	SES	SSS
Age	$\rho = -0.317^{**}$	$\rho = -0.237^{*}$	$\rho = -0.290^{**}$	$\rho = -0.329^{**}$
Gender	t = 1.21	t = 1.76	t = 0.93	t = -0.36
Number of co-existing chronic illnesses[a]	$F = 3.88^{*}$	$F = 4.48^{*}$	$F = 3.50^{*}$	F = 0.36
Hypnotic drugs used in the past	$t = -3.02^{**}$	$t = -3.07^{**}$	$t = -3.62^{***}$	t = -0.38
Hypnotic drugs in current use	$t = -3.25^{**}$	$t = -3.34^{***}$	$t = -3.44^{***}$	t = -0.83
Tracheotomy	t = -1.64	t = -1.17	t = -1.27	$t = -2.16^{*}$
Albumin	$t = 2.27^{*}$	$t = 2.15^{*}$	$t = 2.16^{*}$	t = 1.26
Days of ventilator use	$\rho = -0.04^{*}$	$\rho = -0.07$	$\rho = -0.07$	$\rho = 0.04^{*}$
Glasgow Coma Scale	$\rho = -0.05$	$\rho = -0.05$	$\rho = -0.08$	$\rho = 0.03^{*}$
Disease severity (APACHE II)	$\rho = -0.36^{***}$	$\rho = -0.29^{**}$	$\rho = -0.31^{**}$	$\rho = -0.34^{***}$

Notes: $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$; VSH: Verran and Snyder-Halpern sleep scale; SDS: Sleep disturbance scale; SES: Sleep effectiveness scale; SSS: Sleep supplementation scale; ρ is Spearman's correlation; t is the independent t-test statistic; F is the one-way ANOVA statistic; [a]: Tukey test in oneway ANOVA: 3-4 illnesses < 0 illnesses in VHS, SDS; 3-4 illnesses < 1-2 illnesses and 0 illnesses and in SES.

Table 3.
Comparison of demographic characteristics, disease attributes and quality of sleep by weaning outcome (N = 94)

Variables	Weaned n = 53 (56.4%)	Non-weaned n = 41 (43.6%)	Test statistic	p
Age ª	66.5 (SD 17.6)	73.3 (SD 12.4)	t = -2.10	.038*
≤64y/o	21 (39.6%)	9 (22.0%)		
≥65y/o	32 (60.4%)	32 (78.0%)		
Gender			χ^2 = 0.07	.794
Male	26 (49.1%)	19 (46.3%)		
Female	27 (50.9%)	22 (53.7%)		
Number of co-existing chronic illnesses			χ^2 for trend = 3.29	.070
None	11 (20.7%)	3 (7.3%)		
1-2	32 (60.4%)	30 (73.2%)		
3-4	10 (18.9%)	8 (19.5%)		
History of drinking alcohol	11 (2.8%)	15 (36.6%)	χ^2 = 2.90	.089
Hypnotic drugs used in the past	10 (18.9%)	6 (14.6%)	χ^2 = 2.93	.588
Hypnotic drugs under use	20 (37.7%)	16 (39.0%)	χ^2 = 0.02	.899
Tracheotomy	19 (35.8%)	19 (46.3%)	χ^2 = 1.06	.304
Albumin			χ^2 = 2.15	.142
≥ 3.0 mg/dl	16 (3.2%)	7 (17.1%)		
≤ 2.9 mg/dl	37 (69.8%)	34 (82.9%)		
Days on ventilator ª	37.9 (SD 17.8)	42.5 (SD 20.4)	t = 0.12	.240
Glasgow Coma Scale ª	14.0 (SD 1.4)	13.2 (SD 1.6)	t = 2.91	.005**
Disease severity (APACHE II) ª	7.9 (SD 3.7)	11.3 (SD 3.7)	t = -4.37	< .001***
Total VSH sleep scale ª	45.9 (15.3)	36.1 (SD 16.5)	t = 2.98	.004**
Sleep disturbance scale ª	44.1 (16.9)	33.0 (SD 16.5)	t = 3.18	.002**
Sleep effectiveness scale ª	48.3 (19.1)	36.2 (SD 20.5)	t = 2.95	.004**
Sleep supplementation scale ª	47.5 (61.0)	44.1 (SD 22.3)	t = 0.77	.443

Notes: 1. *p < .05, **p < .01, ***p < .001; VSH: Verran and Snyder-Halpern sleep scale; ª: Continuous variables are presented as Mean (SD).

Table 4.
Logistic regression analyses to predict successful weaning and quality of sleep (N=94)

	Odds ratio	95% Confidence Interval		p	Pseudo-R^2
		Lower	Upper		
Disease severity (APACHE II)	1.644	1.150	2.351		41.0%
Glasgow Coma Scale	0.810	0.695	0.944	.007**	
Total VSH Sleep Scale	1.003	1.001	1.006	.009**	
History of drinking alcohol	0.208	0.063	0.689	.009**	

Notes: **p < .01; APACHE II: Acute Physiology and Chronic Health Evaluation II; VSH: Verran and Snyder-Halpern Sleep Scale.

Table 5 Multiple linear regression analyses to predict quality of sleep (N=94)

	b	β	95% Confidence Interval		p	Adjusted-R^2
			Lower	Upper		
Constant	59.823		52.078	67.568	$< .001^{***}$	25.3%
Disease severity (APACHE II)	-1.323	-.325	-2.052	-0.593	$.001^{**}$	
Hypnotic drugs under use	-10.707	-.317	-16.718	-4.696	$.001^{**}$	
3-4 chronic illnesses	-9.905	-.227	-17.734	-2.077	$.014^{*}$	

Notes: $^{*}p < .05$, $^{**}p < .01$, $^{***}p < 0.001$; APACHE II: Acute Physiology and Chronic Health Evaluation II; VSH: Verran and Snyder-Halpern sleep scale; b is the unstandardized regression coefficient; β is the standardized regression coefficient.