Australian Critical Care xxx (xxxx) xxx

Contents lists available at ScienceDirect

Australian Critical Care

journal homepage: www.elsevier.com/locate/aucc

Research paper

Investigating the construct and concurrent validity of the Richards-Campbell Sleep Questionnaire with intensive care unit patients and home sleepers

Marita Ritmala-Castren, RN PhD [a, b, *]
Anna Axelin, RN, PhD [b]
Kathy C. Richards, PhD, RN [c]
Marion L. Mitchell, RN, PhD [d, e]
Tero Vahlberg, MSc [f]
Helena Leino-Kilpi, RN, PhD [b, g]

[a] Helsinki University Hospital, Po BOX 100, FI-00029 HUS, Finland
[b] Department of Nursing Science, University of Turku, FI-20014 TURUN YLIOPISTO, Finland
[c] University of Texas at Austin, School of Nursing, 1710 Red River St., Austin, TX 78712, USA
[d] School of Nursing and Midwifery, Menzies Health Institute Queensland, Griffith University, N48 2.14, Nathan Campus, 170 Kessels Road, Nathan, Queensland 4111, Australia
[e] Princess Alexandra Hospital Intensive Care Unit, 199 Ipswich Rd, Woolloongabba, Queensland 4102, Australia
[f] Department of Biostatistics, University of Turku, FI-20014 TURUN YLIOPISTO, Finland
[g] Turku University Hospital, PO Box 52, FI-20521 TURKU, Finland

ARTICLE INFORMATION

Article history:
Received 20 May 2020
Received in revised form
16 March 2021
Accepted 17 April 2021

Keywords:
Intensive care
Known-group validity
Richards-Campbell Sleep Questionnaire
Sleep
Sleep quality

ABSTRACT

Background: Sleep is vital to our wellbeing. Critically ill patients are vulnerable with effects of sleep deprivation including weakened immune function, decreased glucose tolerance, and increased sympathetic activity. Intensive care unit (ICU) patients' sleep evaluation is difficult and often not reliable. The most commonly used instrument for assessing ICU patients' perspective of their sleep, Richards-Campbell Sleep Questionnaire (RCSQ), has not been reported to have undergone known-group construct validity testing or concurrent validity testing with the criterion measure of feeling refreshed.
Objectives: The aim of the study was to explore the construct validity of the RCSQ with known-groups technique and concurrent validity with the criterion measure of feeling refreshed on awakening.
Methods: A cross-sectional descriptive survey study using the RCSQ was conducted on people sleeping at home (n = 114) over seven nights. The results were compared with the RCSQ sleep scores of non-intubated alert oriented adult ICU patients (n = 114). Home sleepers were also asked to rate how refreshed they felt on awakening. The study was executed and reported in accordance with the STROBE checklist for observational studies.
Findings: RCSQ construct validity was supported because home sleepers' and ICU sleepers' sleep evaluations differed significantly. Home sleepers rated their sleep significantly better than ICU patients in all five sleep domains of the RCSQ. Concurrent validity was supported because the item "feeling refreshed on awakening" correlated strongly with all sleep domains.
Conclusions: Sleep quality may be accurately measured using the RCSQ in alert people both in the ICU and at home. This study has added to the validity discussion around the RCSQ. The RCSQ can be used for sleep evaluation in ICUs to promote wellbeing and recovery.

* Corresponding author. Helsinki University Hospital, Po BOX 100, FI-00029 HUS, Finland.
E-mail addresses: marita.ritmala-castren@hus.fi (M. Ritmala-Castren), anmaax@utu.fi (A. Axelin), kricha@utexas.edu (K.C. Richards), marion.mitchell@griffith.edu.au (M.L. Mitchell), tero.vahlberg@utu.fi (T. Vahlberg), helena.leino-kilpi@utu.fi (H. Leino-Kilpi).

https://doi.org/10.1016/j.aucc.2021.04.001

1. Introduction

Sleep is vital to our wellbeing as while we sleep, our body and mind are restored. Metabolic waste is cleansed,[1] growth hormone secretion peaks helping the body to heal from possible physical damage, and cortisol secretion is increased.[2] Rapid eye movement phases of sleep that occur in an average of 20% of total sleep time and mostly towards the morning are thought to be important for restructuring memory.[3] Critically ill patients may be particularly vulnerable, with the effects of sleep deprivation reported in studies on healthy people, including weakened immunofunction,[4] decreased secretion of growth hormone,[5] decreased glucose tolerance, and an increase in sympathetic activity,[6] among others, all potentially hazardous to their recovery. Therefore, it is essential to optimise critically ill patients' sleep, and crucial to this is being able to as accurately and reliably measure their sleep while they are being cared for in an intensive care unit (ICU). With reliable sleep evaluation methods, patients' sleep can be monitored and issues can be identified and addressed. The Richards-Campbell Sleep Questionnaire (RCSQ)[7] is a promising tool for reliable sleep assessment, developed specifically for ICU patients' sleep evaluation. However, further validation is required.

2. Background

Evaluation of patients' sleep quality in an ICU is difficult, and the results are often just suggestive.[8–11] ICU patients often lay quietly with their eyes closed even when they are awake, and normal movement during sleep may be restricted owing to a patient's condition and being inhibited by monitoring and life-support technology.[12–14] The RCSQ[7] is the most commonly used instrument for assessing ICU patients' own perspective of their sleep. It measures five domains of sleep quality: sleep depth, falling asleep, number of awakenings (reflecting total amount of sleep), percentage of time awake, and overall quality of sleep, with one item each on a visual analogue scale of 0–100 on a 100-mm line. Zero represents the poorest sleep, and 100, the best possible sleep. A sleep index is calculated as the mean of the five item scores.[7] It has the advantage of being patient-centred and acknowledges the importance of the patient's viewpoint.

The RCSQ was originally developed specifically for ICU patients because other sleep questionnaires were overly long and burdensome for the critically ill to complete.[7] The most comprehensive testing with polysomnography as the criterion measure was performed on 70 nonintubated male patients in a medical ICU. Since the RCSQ's development, it has been successfully used also on intubated patients.[10,15,16] Despite its use internationally in a number of studies,[7,8,15,17–28] the reported validity of the RCSQ has been scarce.

Construct, content, and criterion validity testing of an instrument is necessary to ensure it measures what it intends to measure, especially when the definition or the relationship of the measured variable to its purported cause may vary,[29] as is the case with sleep quality. The RCSQ was developed based on the results of earlier studies of ICU patients' sleep. Its content validity was tested with an expert panel. The criterion validity of the RCSQ was tested using simultaneous polysomnographic (PSG) sleep measurement.[7] Most RCSQ domains reportedly correlated with their corresponding PSG measures. Highest correlations were the percentage of time awake in PSG with RCSQ domain 2, falling asleep after being awoken ($r = -0.59$), and the PSG sleep efficiency index that represents the overall perception of sleep with the sleep index calculated from the five RCSQ items ($r = 0.58$).[7] However, the statistical significance of the aforementioned correlations was not reported.

Construct validity of the RCSQ is scarcely reported, and yet, it is an essential form of validity providing evidence of the instrument's ability to measure complex multifaceted attributes,[30] such as sleep. The first aim of this study was therefore to explore the construct validity of the RCSQ using known-groups technique,[30] determining how adult people sleeping at home rate their sleep quality using the RCSQ and how their sleep evaluations compare with an earlier sample of adult, oriented nonintubated ICU patients.[31] We expected that home sleepers would score significantly higher scores (reflecting better sleep) than ICU patients on the RCSQ. The second aim was to gather further evidence of the RCSQ's concurrent validity by asking home sleepers to rate how refreshed they felt on awakening. The degree to which people perceive their sleep as refreshing is considered a valid measure of sleep quality commonly used by the discipline of sleep medicine,[32,33] but this has not previously been used in association with the RCSQ.

Perhaps owing to the ease of use of the RCSQ, it has also been used in other patient groups, such as lactating mothers,[34] hospitalised elders,[35] patients with AIDS,[36] hospitalised patients with mental health disorders,[37] and also relatives of palliative care patients at home.[38] However, the validity of the RCSQ was not discussed in the aforementioned studies performed outside the ICU. The RCSQ has successfully been used for repeated measurements by the same respondents, either by patients[39] or by patient–nurse pairs.[10]

3. Method

In this cross-sectional descriptive study, a paper-based survey was conducted between May and September 2016 on Finnish people sleeping at home. They evaluated their previous night's sleep using the RCSQ for a duration of 7 nights as that period would give an estimation of the quality of sleep affected by work, school, or other related daily variations. The results were compared with the one-night RCSQ sleep evaluation of nonintubated alert and oriented adult ICU patients with no neurological trauma or surgery and no diagnosed sleep disorders, collected in an earlier survey study.[31] A form of snowball sampling was used to recruit home sleepers via students and personnel of a university and polytechnic's nursing science departments. The inclusion criteria were an adult older than 18 years and capable of answering the survey independently. Participating students and staff, were also requested to pass on the questionnaires to interested family and friends. Students and personnel who chose to participate in the study picked from the delivery box in the institution as many questionnaires as they assumed to use themselves and additional questionnaires to pass on. In total, 260 questionnaires were distributed. The participants were requested to send the completed questionnaire to the researcher via a prepaid envelope.

The Finnish version of the RCSQ, translated and validated in an earlier study,[31] was used. The participants were asked to rate their sleep quality for the previous night using the RCSQ domains—sleep depth, falling asleep, number of awakenings, percentage of time awake, and overall quality of sleep—for a week (seven nights). The participants also rated how refreshed they felt on awakening, which was also measured on a visual analogue scale of 0–100 mm.[40] Demographic characteristics including gender, age, weekday, workday/day off, awakening spontaneously or not, use of sleep medication, and normal/abnormal sleeping conditions were collected as background variables.

The data of nonintubated adult ICU patients were collected from one 16-bed medical–surgical ICU in a university hospital. Patients who potentially qualified to participate were selected by a researcher and an ICU charge nurse and approached by a researcher in the morning after at least one full night in the ICU. Patients who

Please cite this article as: Ritmala-Castren M et al., Investigating the construct and concurrent validity of the Richards-Campbell Sleep Questionnaire with intensive care unit patients and home sleepers, Australian Critical Care, https://doi.org/10.1016/j.aucc.2021.04.001

consented to be included, signed a consent form after receiving both written and verbal information about the study and their involvement. They subsequently rated their previous night's sleep quality using the RCSQ.[31] The data were used for the analysis of group differentiation. Gender, age, and use of sleep medication were common demographic characteristics across both ICU and home sleeper participants.

Data were analysed statistically using IBM SPSS Statistics, version 22.0 (IBM Corp., Armonk, NY). Participant characteristics were reported using frequencies, mean, and standard deviation. In line with the RCSQ instructions, a sleep index was calculated as a mean of the five RCSQ items. Means of the 7 nights' evaluations of each RCSQ item were calculated for each participant to describe the home sleepers' quality of sleep. Mean ages between patient and home sleeper groups were compared using the two-sample t-test. The chi-square test was used to test difference in gender distribution.

Correlations between the RCSQ domains and refreshed feeling were calculated using the Spearman correlation coefficient. An age- and gender-adjusted analysis of covariance was used to analyse the differences between the sleep evaluations of home sleepers and the previously collected ICU patients' evaluations[31] as age and gender were the potential confounding factors in both groups. Inverse normal transformation (Blom's method[41]) RCSQ values were used in analysis of covariance owing to non-normally distributed RCSQ data. Linear mixed model with random intercept for participants was used to compare feeling refreshed between workdays and days off and between awakening spontaneously and not among home sleepers. Internal consistency of the RCSQ was measured using the calculation of Cronbach's alpha of the whole data and also separately for the home sleepers and the ICU participants. The level of statistical significance was set at $p < 0.05$. The study was executed and reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist for observational studies.

The participant information letter that accompanied the questionnaire informed potential participants about the voluntary nature of participation and the anonymity of questionnaire responses. Consent was inferred by return of the questionnaire. Ethical approval from the Ethics Board of Helsinki University Hospital and official permission from the hospital authorities were provided for the study on ICU patients. An official permit to recruit the participants was obtained from authorities of the University of Turku and the Laurea polytechnic.

4. Results

The mean age of the 114 participating ICU patients was 59 years (standard deviation [SD] = 14, range = 25–87), and 37% were women[31] (Table 1). The mean sleep index was 54 mm (SD = 28.8 mm). Of the RCSQ sleep domains, ICU patients rated falling asleep in the evening the highest (mean = 63, SD = 32.3 mm) and sleep depth the lowest (mean = 44, SD = 33.6 mm) (Table 2, Fig. 1).

By coincidence, 114 surveys were returned from home sleeping participants. The mean age of the home sleeping participants was 48 years (SD = 15.4, range = 18–80 years), with 61% women (Table 1).

In total, there were 798 nights of sleep reported via the surveys. Missing values were very few, except for the item pertaining to falling asleep again if woken during the night. Most of the participants who left it unanswered (n = 54) had evaluated the number of awakenings as none or very few, so they may have concluded that the item did not apply to them. The participants appeared to complete the sleep evaluations with consideration as the responses to each question varied widely per participant amongst the 7 nights. The mean range of the participant's responses to each question within the seven nights was 41 mm (SD = 23.2 mm) out of a possible 100 mm.

Sleeping conditions at home were noted by the participants as 'normal' on 89% of the nights, indicating there were few nights when their sleeping conditions differed from normal, such as not

Table 1
Characteristics of the ICU patients and the home sleepers.

Characteristic	ICU patients, n = 114					Home sleepers, n = 114					p
	%	Mean	SD	Minimum	Maximum	%	Mean	SD	Minimum	Maximum	
Gender, female/male	37/63					61/39					<0.001
Age, years		59	14.1	25	87		48	15.4	18	80	<0.001
Used sleep medication	25					2					
Work/day off						47/53					
Woke spontaneously/was woken						53/47					
Normal sleep circumstances						89					

SD, standard deviation; ICU, intensive care unit.

Table 2
Sleep estimations of ICU patients and the persons sleeping at home, measured with RCSQ and the feeling refreshed item on the scale (range = 0–100 mm).

Sleep domain (0–100 mm)	ICU patients' estimations (n = 114)		Home sleepers' estimations (n = 114)		p*
	Mean/median, mm	SD, mm	Mean/median, mm	SD, mm	
Sleep depth	44/35	33.6	75/78	14.9	<0.001
Falling asleep	63/74	32.3	77/79	14.0	0.023
Number of awakenings	52/48	31.9	78/78	13.8	<0.001
Percentage of time awake	60/70	33.2	73/77	20.9	0.014
Sleep quality	50/53	35.3	73/73	14.9	<0.001
Sleep index	54/55	28.8	76/78	13.5	<0.001
Feeling refreshed (0–100)			65/65	16.6	

ICU, intensive care unit; SD, standard deviation; RCSQ, Richards-Campbell Sleep Questionnaire.
*Age- and gender-adjusted analysis of covariance; inverse normal transformation RCSQ values were used owing to non-normally distributed RCSQ data.

Please cite this article as: Ritmala-Castren M et al., Investigating the construct and concurrent validity of the Richards-Campbell Sleep Questionnaire with intensive care unit patients and home sleepers, Australian Critical Care, https://doi.org/10.1016/j.aucc.2021.04.001

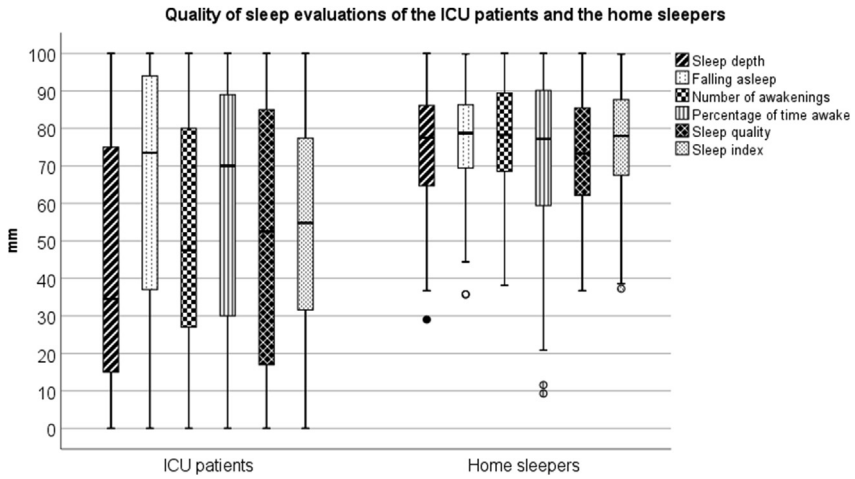

Fig. 1. RCSQ evaluation of the sleep quality by the ICU patients and the home sleepers: scale = 0 mm (poorest sleep) to 100 mm (best sleep). ICU, intensive care unit; RCSQ, Richards-Campbell Sleep Questionnaire.

sleeping at home (6%), sleeping with someone other than the usual bed companion (1%), or sleeping alone when this was unusual for them (4%). Approximately half of the days were participants' work or school days (47%, n = 761). On 27% (n = 353) of those days, the participants woke up spontaneously, whereas on a day off, 76% (n = 408) woke up spontaneously. The participants took sleep medication in the evening on only 14 nights (2%, n = 749).

Measured using the RCSQ, the home sleepers' mean sleep index was 76 (SD = 13.5). Of the five sleep domains, the amount of sleep (mean = 78 mm, SD = 13.8 mm) and falling asleep again (mean = 73 mm, SD = 20.9 mm) were rated the highest and the general estimation of the sleep quality was the lowest (mean = 73 mm, SD = 14.9 mm) (Fig. 1). Gender did not associate with the sleep index or any of the RCSQ sleep domains. Age had weak, but statistically significant, correlations with the amount of sleep ($r = -0.24$, $p = 0.011$), number of awakenings ($r = -0.20$, $p = 0.034$), sleep quality ($r = -0.28$, $p = 0.003$), and mean sleep index ($r = -0.26$, $p = 0.005$).

Regarding the comparison of home sleepers' evaluations with ICU patients' sleep evaluations, participants sleeping at home self-reported their sleep as significantly better on all domains than oriented, non-intubated adult participants (Table 1). The percentage of time awake was estimated the highest of all the sleep domains by home sleepers, whereas ICU patients estimated falling asleep the highest. The variation between different sleep domains was much smaller in home sleepers' evaluations (65–78 mm) than in ICU patients' evaluations (44–63 mm). Patients were significantly older (mean = 59 years, SD = 14.1, range = 25–87 years) than the home sleepers (mean = 48 years, SD = 15.4, range = 18–80 years) ($p < 0.001$). There was a significantly greater proportion of men in the patient group (63% vs. 39%, $p < 0.001$), as generally occurring in the ICU population.[42]

The home sleepers felt significantly more refreshed on a day off (mean = 70 vs. 59, $p < 0.001$) and if they woke up spontaneously (mean = 72 vs. 58, $p < 0.001$). Participants feeling refreshed as they woke up (the additional item) correlated significantly with all the sleep domains of the RCSQ (Table 3).

The internal consistency of the RCSQ measured using Cronbach's alpha was very good both in patients' (0.92) and in home sleepers' (0.87) group. The Cronbach's alpha for both data sets combined was 0.89.

5. Discussion

The first aim of this study was to contribute to the evidence of the construct validity of the RCSQ, specifically by group differentiation, by comparing the sleep evaluations of adults sleeping at home with ICU patients' evaluations. The validity of the data was dependent on the honesty and reflection/perceptions of the individual and was therefore limited by these factors as is the case with the RCSQ used elsewhere. However, as expected, persons sleeping at home reported much better sleep than ICU patients, which indicates good discriminative property of the RCSQ. In addition, the wider range between different sleep domains in ICU patients' evaluations compared with home sleepers' evaluations supports the discriminative properties of the RCSQ. The RCSQ has not been reported to have been used in a general population before, only in people outside the hospital with extraordinary circumstances; lactating mothers (n = 98) in the first 6 weeks postpartum,[34] and relatives caring for dying patients at home.[38] Thus, these current results add to the research evidence on the RCSQ's broad application. Hill et al.[34] did not report the actual RCSQ results of the lactating mother's sleep quality, hence limiting comparisons. The sleep of the relatives (n = 75) caring for dying patients at home was poorer than the home sleepers' sleep in this study in all domains, which also indicates good discriminative property of the RCSQ. The relatives rated sleep depth the poorest of the five domains (mean = 58 mm, SD = 27.9 mm), as did the ICU patients in our study, and female relatives experienced significantly poorer sleep quality than male relatives.[38]

The specific sleeping concern for ICU patients is known to be light and fractional sleep when measured via PSG, the gold standard of sleep evaluation.[18,43] Our results using the RCSQ support this finding and that of other previous studies,[9,26,27] wherein ICU patients feel they can fall asleep somewhat easily; however, their sleep is light and awakenings are frequent.

Table 3
Correlations of different sleep domains of the RCSQ with the item feeling refreshed at awakening in home sleepers' estimations (n = 114).

RCSQ sleep domain	Refreshed feeling	
	Spearman correlation	P
Sleep depth	0.70	<0.001
Fall asleep	0.60	<0.001
Sleep amount	0.61	<0.001
Fall asleep again	0.51	<0.001
Sleep quality	0.72	<0.001
Sleep index	0.70	<0.001

RCSQ, Richards-Campbell Sleep Questionnaire.

Please cite this article as: Ritmala-Castren M et al., Investigating the construct and concurrent validity of the Richards-Campbell Sleep Questionnaire with intensive care unit patients and home sleepers, Australian Critical Care, https://doi.org/10.1016/j.aucc.2021.04.001

Our second aim was to explore the concurrent validity of the RCSQ by measuring how refreshing the sleep of the home sleepers had been. Strong correlation of the additional item of feeling refreshed on awakening and the sleep quality measured using the RCSQ provides a new way to examine concurrent validity that is more readily achievable than using PSG. Richards et al.[7] demonstrated in their original RCSQ development study good correlation between the RCSQ items and PSG. The item “feeling refreshed on awakening” is commonly used in evaluation of sleep difficulties in healthy people.[32] Additional research is needed to analyse if it would translate to ICU patients as they are known to experience fatigue during ICU care,[44] which may affect their ability to evaluate their feeling of being refreshed by the previous night's sleep. Alternatively, as the single item “sleep quality” correlated highest with the item “ feeling refreshed on awakening” , it may be worth studying if it would qualify as a single item to reflect sleep quality of ICU patients.A limitation of this study conducted in Finland is that the sample size was relatively small. However, an attempt was made to capture the natural variation in sleep patterns by asking for a week of reflections on each night's sleep for the home sleepers. By coincidence, the sample number of home sleepers was exactly the same as the previous sample of ICU patients. However, the samples differed by age and gender, which was taken into account in analyses. In addition, the questionnaires of seven nights from each participant sleeping at home were noted and taken into account during data analysis. Another limitation concerns the lack of objective sleep measures in this study. The use of polysomnography (PSG) would have further validated the results. However, PSG is burdensome, and its use in ICU patients has acknowledged challenges regarding technical issues and scoring reliability, among others.[45] Thus, it was not an option in this study. Nonetheless, this should be considered for future research.

The third limitation relates to background data collection. Data on potential confounding factors, such as the presence of chronic illnesses, use of medications known to affect sleep quality, or shift work scheduling, could have been collected to further compare the two groups. Various extrinsic and intrinsic factors affect sleep both at home and in the ICU. However, the purpose of this study was not to compare sleep at home and in an ICU but to explore the validity of the RCSQ, and the sample size of more than 100 in each group was representative of this purpose. A future study could examine the factors influencing sleep deprivation as this was beyond the scope of the present study.

In previous research, mean scores of sleep quality at home have been reported to be 7.00,[46] 7.03,[47] 7.06,[48] and 6.81[49] on a Sleep in the ICU Questionnaire [46] scale of 1 to 10 when the respondents rated their sleep at home retrospectively during the ICU stay. Derived from that, a cut-off point of 70 has been used to determine good and poor sleep.[22] However, in our study, home sleepers' mean sleep quality (73) and sleep index (76) were higher when measured using the RCSQ. Hence, further research is needed to establish the cut-off point for good and poor sleep.

The RCSQ seems to perform well with healthy home sleepers; hence, its performance in patients requiring home care or sleeping in hospital wards should also be investigated. Furthermore, evidence of the RCSQ's sensitivity to measure the impact of sleep promotion interventions would strengthen its value as an ICU patients' sleep evaluation tool.

6. Conclusion

The RCSQ accurately measures quality of sleep in alert people both in the ICU and at home. This is the first study that has positively evaluated its construct validity by way of known-group technique using home sleepers and ICU patients and concurrent validity using the single-item score of feeling refreshed, thus adding to the validity discussion around the RCSQ. The measure, feeling refreshed, showed strong correlation with the RCSQ, thus adding a further dimension to sleep research. The RCSQ can be used for sleep evaluation in ICUs to promote wellbeing and recovery.

Funding

This study was financially supported by the Nursing Research Center of Helsinki University Hospital, the Finnish Nursing Education Foundation, and the Finnish Sleep Research Society. The study was conducted independently of the funding bodies.

CRediT authorship contribution statement

Marita Ritmala-Castren: Conceptualisation, Methodology, Investigation, Writing – original draft, Project administration, Funding acquisition; **Anna Axelin**: Conceptualisation, Methodology, writing – reviewing and editing; **Kathy C. Richards**: Methodology, Writing – reviewing and editing; **Marion L. Mitchell**: Conceptualisation, Writing – original draft; **Tero Vahlberg**: Formal analysis, Writing – reviewing and editing; **Helena Leino-Kilpi**: Conceptualisation, Supervision.

Conflict of interest

None.

Acknowledgements

The authors wish to thank the university and polytechnic staff and all the master's and nursing students who assisted in recruiting home sleepers for this study.

Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.aucc.2021.04.001.

References

[1] Xie L, Kang H, Xu Q, Chen MJ, Liao Y, Thiyagarajan M, et al. Sleep drives metabolite clearance from the adult brain. Science 2013 October 18;342(6156). https://doi.org/10.1126/science.1241224.
[2] Czeisler CA, Buxton OM. The human circadian timing system and sleep–wake regulation. In: Kryger MH, Roth T, Dement WC, editors. Principles and practice of sleep medicine. St. Louis, Missouri: Elsevier Saunders; 2011. p. 402–19.
[3] Hardin KA, Seyal M, Stewart T, Bonekat HW. Sleep in critically ill chemically paralyzed patients requiring mechanical ventilation. Chest 2006;129(6):1468–77.
[4] Ganz FD. Sleep and immune function. Crit Care Nurse 2012;32(2):e19–25.
[5] Banks S, Dinges DF. Chronic sleep deprivation. In: Kryger MH, Roth T, Dement WC, editors. Principles and practice of sleep medicine. St. Louis, Missouri: Elsevier Saunders; 2011. p. 67–75.
[6] Spiegel K, Leproult R, Van Cauter E. Impact of sleep debt on metabolic and endocrine function. Lancet 1999;354(9188):1435–9.
[7] Richards KC, O'Sullivan PS, Phillips RL. Measurement of sleep in critically ill patients. J Nurs Meas 2000;8(2):131–44.
[8] Darbyshire JL, Borthwick M, Edmonds P, Vollam S, Hinton L, Young JD. Measuring sleep in the intensive care unit: electroencephalogram, actigraphy, or questionnaire? J Intensive Care Soc 2020;21(1):22–7.
[9] Aitken L, Elliott R, Mitchell M, Davis C, Ullman A, McFarlane B, et al. Sleep assessment by patients and nurses in the intensive care: a prospective cohort study. Aust Crit Care 2017;30(2):59–66.
[10] Kamdar BB, Shah PA, King LM, Kho ME, Zhou X, Colantuoni E, et al. Patient-nurse interrater reliability and agreement of the Richards-Campbell sleep questionnaire. Am J Crit Care 2012;21(4):261–9.
[11] Beecroft JM, Ward M, Younes M, Crombach S, Smith O, Hanly PJ. Sleep monitoring in the intensive care unit: comparison of nurse assessment, actigraphy and polysomnography. Intensive Care Med 2008;34(11):2076–83.

[12] Ritmala-Castren M, Lakanmaa RL, Virtanen I, Leino-Kilpi H. Evaluating adult patients' sleep: an integrative literature review in critical care. Scand J Caring Sci 2014;28(3):435–48.
[13] Hoey LM, Fulbrook P, Douglas JA. Sleep assessment of hospitalised patients: a literature review. Int J Nurs Stud 2014;51(9):1281–8.
[14] Jeffs EL, Darbyshire JL. Measuring sleep in the intensive care unit: a critical appraisal of the use of subjective methods. J Intensive Care Med 2017;34(9):751–76.
[15] Elliott R, McKinley S, Cistulli P, Fine M. Characterisation of sleep in intensive care using 24 hour polysomnography: an observational study. Crit Care 2013;17(2):R46.
[16] Kamdar BB, Niessen T, Colantuoni E, King LM, Neufeld KJ, Bienvenu OJ, et al. Delirium transitions in the medical ICU: exploring the role of sleep quality and other factors. Crit Care Med 2015;43(1):135–41.
[17] Frisk U, Nordstrom G. Patients' sleep in an intensive care unit–patients' and nurses' perception. Intensive Crit Care Nurs 2003;19(6):342–9.
[18] Bourne RS, Mills GH, Minelli C. Melatonin therapy to improve nocturnal sleep in critically ill patients: encouraging results from a small randomised controlled trial. Crit Care 2008;12(2):R52.
[19] Nicolas A, Aizpitarte E, Iruarrizaga A, Vazquez M, Margall A, Asiain C. Perception of night-time sleep by surgical patients in an intensive care unit. Nurs Crit Care 2008;13(1):25–33.
[20] Li SY, Wang TJ, Vivienne Wu SF, Liang SY, Tung HH. Efficacy of controlling night-time noise and activities to improve patients' sleep quality in a surgical intensive care unit. J Clin Nurs 2011;20(3–4):396–407.
[21] Faraklas I, Holt B, Tran S, Lin H, Saffle J, Cochran A. Impact of a nursing-driven sleep hygiene protocol on sleep quality. J Burn Care Res 2013;34(2):249–54.
[22] Kamdar BB, King LM, Collop NA, Sakamuri S, Colantuoni E, Neufeld KJ, et al. The effect of a quality improvement intervention on perceived sleep quality and cognition in a medical ICU. Crit Care Med 2013;41(3):800–9.
[23] McKinley S, Fine M, Elliott R, Elliott D. Sleep and psychological health during early recovery from critical illness: an observational study. J Psychosom Res 2013;75(6):539–45.
[24] Maidl CA, Leske JS, Garcia AE. The influence of "quiet time" for patients in critical care. Clin Nurs Res 2014;23(5):544–59.
[25] Patel J, Baldwin J, Bunting P, Laha S. The effect of a multicomponent multidisciplinary bundle of interventions on sleep and delirium in medical and surgical intensive care patients. Anaesthesia 2014;69(6):540–9.
[26] Krotsetis S, Richards KC, Behncke A, Kopke S. The reliability of the German version of the Richards Campbell sleep questionnaire. Nurs Crit Care 2017;22(4):247–52.
[27] Navarro-Garcia MA, de Carlos Alegre V, Martinez-Oroz A, Irigoyen-Aristorena MI, Elizondo-Sotro A, Indurain-Fernandez S, et al. Quality of sleep in patients undergoing cardiac surgery during the postoperative period in intensive care. Enfermería Intensiva 2017;28(3):114–24.
[28] van de Pol I, van Iterson M, Maaskant J. Effect of nocturnal sound reduction on the incidence of delirium in intensive care unit patients: an interrupted time series analysis. Intensive Crit Care Nurs 2017;41:18–25.
[29] Streiner DL, Norman GR. Health Measurement Scales: a practical guide to their development and use. 4th ed. New York: Oxford University Press Inc.; 2008.
[30] Price LR. Psychometric methods: theory into practice. New York: The Guilford Press; 2017.
[31] Ritmala-Castren M, Axelin A, Kiljunen K, Sainio C, Leino-Kilpi H. Sleep in the intensive care unit - nurses' documentation and patients' perspectives. Nurs Crit Care 2017;22(4):238–46.
[32] Libman E, Fichten C, Creti L, Conrod K, Tran DL, Grad R, et al. Refreshing sleep and sleep continuity determine perceived sleep quality. Sleep Disorders 2016. https://doi.org/10.1155/2016/7170610.
[33] Knufinke M, Nieuwenhuys A, Geurts SAE, Coenen AML, Kompier MAJ. Self-reported sleep quantity, quality and sleep hygiene in elite athletes. J Sleep Res 2018;27(1):78–85.
[34] Hill PD, Aldag JC, Chatterton RT, Zinaman M. Psychological distress and milk volume in lactating mothers. West J Nurs Res 2005;27(6):676–93.
[35] Lareau R, Benson L, Watcharotone K, Manguba G. Examining the feasibility of implementing specific nursing interventions to promote sleep in hospitalized elderly patients. Geriatr Nurs 2008;29(3):197–206.
[36] Ownby KK. Effects of ice massage on neuropathic pain in persons with AIDS. J Assoc Nurses AIDS Care 2006;17(5):15–22.
[37] de Niet G, Tiemens B, Hutschemaekers G. Can mental healthcare nurses improve sleep quality for inpatients? Br J Nurs 2010;19(17):1100–5.
[38] Carlsson ME. Sleep disturbance in relatives of palliative patients cared for at home. Palliat Support Care 2012;10(3):165–70.
[39] Menear A, Elliott R, Aitken LM, Lal S, McKinley S. Repeated sleep-quality assessment and use of sleep-promoting interventions in ICU. Nurs Crit Care 2017;22(6):348–54.
40 Wewers ME, Lowe NK. A critical review of visual analogue scales in the measurement of clinical phenomena. Res Nurs Health 1990;13(4):227–36.
41 Altman DG. Practical Statistics for medical research. 1st ed. London: Chapman and Hall; 1991.
42 Garland A, Olafson K, Ramsey CD, Yogendran M, Fransoo R. Epidemiology of critically ill patients in intensive care units: a population-based observational study. Crit Care 2013;17(5):R212.
43 Kushida CA, Littner MR, Morgenthaler T, Alessi CA, Bailey D, Coleman Jr J, et al. Practice parameters for the indications for polysomnography and related procedures: an update for 2005. Sleep 2005;28(4):499–521.
44 Matthews EE. Sleep disturbances and fatigue in critically ill patients. AACN Adv Crit Care 2011;22(3):204–24.
45 Richards KC, Wang Y-y, Jun J, Ye L. Systematic review of sleep measurement in critically ill patients. Front Neurol 2019;11:542529.
46 Freedman NS, Kotzer N, Schwab RJ. Patient perception of sleep quality and etiology of sleep disruption in the intensive care unit. Am J Respir Crit Care Med 1999;159(4):1155–62.
47 Bihari S, McEvoy RD, Matheson E, Kim S, Woodman RJ, Bersten AD. Factors affecting sleep quality of patients in intensive care unit. J Clin Sleep Med 2012;8(3):301–7.
48 Elliott R, Tapan Rai B, McKinley S. Factors affecting sleep in the critically ill: an observational study. J Crit Care 2014;29(5):859–63.
49 Caruana N, McKinley S, Elliott R, Gholizadeh L. Sleep quality during and after cardiothoracic intensive care and psychological health during recovery. J Cardiovasc Nurs 2018;33(4):E40–9.

Please cite this article as: Ritmala-Castren M et al., Investigating the construct and concurrent validity of the Richards-Campbell Sleep Questionnaire with intensive care unit patients and home sleepers, Australian Critical Care, https://doi.org/10.1016/j.aucc.2021.04.001