ORIGINAL RESEARCH

DOI: 10.4274/ejgg.galenos.2023.2022-10-6
Eur J Geriatr Gerontol 2023;5(2):108-115

The Effect of Environmental Modifications on Preventing Delirium for the Elderly Patients in the Intensive Care Unit: A Non-randomized Controlled Trial

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Abstract

Objective: The study aimed to examine the effect of environmental modifications on preventing delirium for the elderly patients in the intensive care unit. A quasi-experimental study with non-randomized independent two groups.

Materials and Methods: The study was conducted at a hospital in Bolu, Turkey. The sample was constituted of 60 patients who met the inclusion criteria. In the intervention group (30 patients), the sound level of the environment was improved, the bright light, a largely written calendar and clock were used, and were allowed to use their glasses or hearing aids if they had. No extra regulation has been made regarding the temperature or humidity of the environment.

Results: Mean humidity level and the mean sound level in the unit were different, while the mean of the temperature was similar between the groups. The mean sound level was higher in control group. In the intensive care unit, the frequency of delirium was 56.7%, and the risk of delirium was 2.32 times higher in the control group.

Conclusion: The study provides scientific evidence to reduce the risk of delirium by a specific care bundle include nursing interventions for elderly patients in intensive care units.

Keywords: Delirium, environment, elderly, intensive care, nursing

Introduction

Delirium is a mental state disorder characterized by impairment of cognitive functions, inadequate attention, decreased or increased psychomotor activity, and changes in the sleep-wake cycle (1). Various risk factors, including age, physiological problems, and environmental conditions, prepare and trigger the development of delirium in older intensive care unit (ICU) patients (2-4).

Delirium progresses with a wide variety of variables. In the literature, delirium in older ICU patients was found to have broad range of frequency (30-73.4%) (5-10). Although different intensive care environments, study samples, methods, and instruments used to measure delirium cause this situation, delirium may frequently occur in patients over 65 years of age, in hospitals, and especially in ICUs. Although delirium is a reversible condition, it can also lead to various complications such as long-term cognitive and functional impairment, prolonged hospitalization, and institutionalization. Since delirium is frequent in this patient group, difficult to diagnose because it is confused with dementia and increases the risk of mortality and morbidity and the cost of care, delirium is a fundamental health problem (11). There is no golden bullet for the treatment of delirium, that is why the prevention of delirium is the most effective strategy (5).

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Received: 28.10.2022 **Accepted:** 06.01.2023

Cite this article as: Çavuşoğlu A, Akman Yılmaz A. The Effect of Environmental Modifications on Preventing Delirium for the Elderly Patients in the Intensive Care Unit: A Non-randomized Controlled Trial. Eur J Geriatr Gerontol 2023;5(2):108-115

Especially, some studies emphasized environmental factors' considerable importance. Arenson et al. (12) stated that the environment has an effect on delirium after cardiovascular surgery. Exposure of patients to high noise levels in ICUs may contribute to sleep disturbance and delirium development (13,14). In studies where sound levels were measured in hospital environments, it has been reported that the noise level reached 75 dB (A) during the day and over 40 dB (A) at night (14,15).

Van Rompaey et al. (16) investigated the effect of noise on sleep quality and delirium risk and found that the use of earplugs at night improved sleep quality and decreased delirium frequency. Based on this information, it can be said that both excessive and insufficient environmental stimuli cause or worsen delirium. The ICU nurses play a key role in the management of environmental stimuli. As stated within the scope of the "Delirium Management" in the Nursing Interventions Classification System, nurses make many interventions to eliminate or reduce the risk of delirium development such as using photographs of the patients' relatives, calendars, and clock, ensuring a calm and relaxing environment, appropriate lighting and reducing noise (17-19).

Considering the relevant literature, it was seen that the importance of environmental modifications was emphasized, but only environmental modifications such as noise level and bright light were evaluated, and there was no comprehensive study investigating the effect of delirium by controlling environmental modifications for older patients. This study was conducted to examine the impact of a specific care bundle including many nursing interventions about environmental modifications on delirium.

Materials and Methods

Study Design

This research was carried out in the anesthesia and reanimation ICU at a public hospital. The study design was a quasi-experimental study with non-randomized independent two groups. A routine care was provided to the control group. The intervention group implemented a specific care bundle that included nursing interventions to prevent a delirium. The delirium was measured during the patients' stay in ICU.

Sample

The sample size of the study was determined according to the power analysis. During the study, the first 30 patients who were treated in the ICU, who had the inclusion criteria and volunteered to participate in the study constituted the control group, and the next 30 patients were the intervention group. The inclusion criteria were an age 65 years and over, being in the ICU for at least 48 hours, having eight or over for Glasgow Coma scale (GCS) score, 3 or over for Richmond agitation sedation scale (RASS) scores, not being diagnosed with psychiatric disorder such as Dementia/Alzheimer's or substance addicts, no any electrolyte imbalances and no severe visual or hearing problems.

The Instruments for Data Collection

Patient information form: The form, which was prepared by the researchers by reviewing the literature (7-9,17,20-24), consisted of 16 questions including the descriptive characteristics of the patients and some follow-up data in the ICU.

GCS: It was used to evaluate the consciousness of patients and consists of three parts: Eye-opening, motor, and verbal response. The response of the patients to the stimuli given in these three areas is evaluated and scored. GCS score must be 8 and over to apply CAM-ICU scale to patients. If the score was 8 or less the patient was considered comatose and cannot be evaluated.

RASS: It was used to assess the patient's agitation state. RASS indicates whether the patient is under deep sedation or fully conscious. The total score is between -5 and +4. If the score was -4 and -5 the patient was considered unconscious and the CAM-ICU scale was not applied to the patient.

The confusion assessment method for the intensive care unit (CAM-ICU): The CAM, developed by Inouye et al. (25) was modified by Ely et al. (26) to use for ICU patients. Turkish validity and reliability study of the scale was performed by Akıncı et al. (5) and its reliability was found 0.96.

In the study, this scale was preferred for the diagnosis of delirium because of being use easily by other health professionals than the psychiatrist, an instrument recommended by the clinical guidelines (8), and being available to the valid and reliable Turkish version of the scale.

The scale was a first time filled in 24 hours of the patient's admission to the ICU. Then, an evaluation was made once a day. It was marked (+) if delirium developed in the patient, and (-) if there was no. If the answers in the first subtitle were no, it was accepted that the patient did not have delirium.

Noise-temperature-humidity monitoring form: This form was developed by the researchers. It was used to record the mean of the noise-temperature-humidity levels measured by the device during the day. The noise level in ICU was measured by a decibel meter funding by Bolu Abant İzzet Baysal University Scientific Research Projects Unit. Temperature and humidity levels were measured by a temperature and humidity meter existing in the ICU.

Data Collection

Control group: The first 30 patients meeting the inclusion criteria were included in the control group. The group took a routine care in ICU. The routine care includes nursing practices such as informing the patient about the procedures, providing the patient's orientation, addressing the patient by name,

and allow their relatives to visit. No additional regulation had been made for these patients in the ICU environment. While collecting the first data from the patients, each of the data collection instruments was used simultaneously. CAM-ICU was evaluated daily. RASS and GCS scores are needed for CAM-ICU evaluation and have to be sufficient. Thus, RASS, and GCS were also measured daily.

Intervention group: For the next 30 patients who were treated in the ICU and met the inclusion criteria, the sound level of the environment was controlled by reducing the volume of the device alarms, by speaking in a low voice during the delivery, or making the conversations in a different environment rather than around the patient. The indoor humidity level was between 30-60% in line with the recommendation of WHO. In our study, no tools were used to humidify the environment. The control group data were collected between September-April and intervention group data was collected between May-July in accordance with the records kept in the ICU to maintain the humidity level of the environment at the desired levels in the intervention group. In addition, patients were allowed to use glasses or hearing aids if they had, and a large written clock and calendar were hung somewhere they could easily see. Bright light (10.000 lux) was also applied for a total of two hours between 12:00-14:00 with a daylight lamp funding by the university scientific research projects unit. Patients were warned not to look directly at the lamp, and the device was placed 60-80 cm away from the patient and in such a way that the light would come to the patient at an angle of 60°. Besides all these environmental changes patients in the intervention group was always received full routine care. Data collection was evaluated similarly with the control group. The first researcher collected all data.

What is already known?

- Delirium is a problem quite common in older intensive care unit patients.
- Several predisposing factors, including age, physiological problems, and environmental conditions, prepare and trigger the development of delirium in this patient group.
- Delirium can lead to various complications such as long-term cognitive and functional impairment. These complications induce prolonged hospitalization, institutionalization, increased mortality and morbidity, and costs.
- Control of sound levels and light treatment could be effective to prevent delirium.

What this paper adds to existing literature and clinical practice?

- To control environmental stimuli with a specific care bundle in the study reduced the delirium risk by 2.32 times in older intensive care unit patients.
- The clinicians should consider the effect of humidity levels on delirium in this patient group.
- The randomized controlled studies are needed to examine the effect of humidity levels on delirium.

Statistics

The data were analyzed using the SPSS version 21. Numerical data analyzed with mean, standard deviation, minimum and maximum values while frequency and percentage distributions were used to analyze categorical data. The normality assumption from the parametric test assumptions was examined using the Shapiro-Wilks test. To examine whether the difference between the two groups was significant or not, the student t-test was used when the assumptions were provided, and the Mann-Whitney U test was used if not. Whether there is a difference between groups in variables that vary with time (in repeated measurements) was examined with the help of generalized linear models. The level of significance was taken as $p<0.05$.

Ethical Considerations

Ethical approval was obtained from the Ethics Committee of Bolu Abant İzzet Baysal University Human Research in Social Sciences (2017/9). Written permissions was obtained from the hospital administration for the application of the study, and from patients and/or patient relatives with the informed consent form.

Results

The mean age of the participants was 75.5±8.2. Approximately two-thirds of the patients (63.3%) were male and married (61.7%), and 40% were literate. 56.7% of the patients had chronic diseases. They had frequent hypertension (26.7%), chronic obstructive pulmonary disease (16.7%), and cancer (15%). The majority (88.3%) of the patients had experienced sleep problems (Table 1).

The mean of the APACHE II score was 17.3±3.9 in the control group and 16.8±4.0 was in the intervention group. The mean RASS value of the patients was calculated as 0.4±1.6. These ICU scores between the groups were not statistically different ($p>0.05$). However, a statistically significant difference was found between the control group and intervention group in terms of the mean of the GCS points ($p=0.004$) (Table 2).

When the environmental factors between the groups were examined, it was found that the mean humidity level in the ICU was 33.5±4.8 in the control group and 35.7±4.5 was in the intervention group. The mean sound level in the ICU was 56.3±2.6 dB in the control group and 50.3±2.1 dB was in the intervention group. These differences between the groups were found to be statistically significant ($p<0.001$) (Table 3).

It was determined that 56.7% of ICU patients participating in the study developed delirium. When the frequency of delirium

Table 1. The comparison of the socio-demographic and medical characteristics of the groups

Characteristics	Control group	Intervention group	Total	p
Age (x̄) ± SD	74.7±8.5	76.7±8.0	75.5±8.2	0.31
Gender	**n (%)**	**n (%)**	**n (%)**	
Female	12 (40)	10 (33.3)	22 (36.7)	0.59
Male	18 (60)	20 (66.7)	38 (63.3)	
Marital status				
Married	15 (50)	22 (73.3)	37 (61.7)	0.06
Single	15 (50)	8(26.7)	23 (38.3)	
Education status				
Illiterate	7 (23.3)	3 (10)	10 (16.7)	0.08
Literate	10 (33.3)	14 (46.7)	24 (40)	
Primary school	10 (33.3)	13 (43.3)	23 (38.3)	
Secondary school	3 (10)	0	3 (5)	
Presence of chronic diseases				
Yes	17 (56.7)	17 (56.7)	34 (56.7)	1
No	13 (43.3)	13 (43.3)	26 (43.3)	
Current chronic diseases				
Hypertension	10 (33.3)	6 (20)	16 (26.7)	0.24
COPD	5 (16.7)	5 (16.7)	10 (16.7)	1
Cancer	6 (20)	3 (10)	9 (15)	0.47
Diabetes	2 (6.7)	6 (20)	8 (13.3)	0.25
Stroke	1 (3.3)	2 (6.7)	3 (5)	1
Heart failure	2 (6.7)	1 (3.3)	3 (5)	1
Other*	3 (10)	1 (3.3)	4 (13.3)	0.39
Sleeping problems				
Yes	24 (80)	29 (96.7)	53 (88.3)	0.10
No	6 (20)	1 (3.3)	7 (11.7)	
Mechanical ventilation				
Yes	7 (23.3)	10 (33.3)	17 (28.3)	0.39
No	23 (76.7)	20 (66.7)	43 (71.7)	
Mechanical ventilation days (x̄) ± SD	5.4±4.5	2±0.9	3.4±3.3	0.08
Hospitalization days (x̄) ± SD	8.4±6.1	7.9±3.7	8.1±5.0	0.81

*AF (n=1; 1.7%), lymphedema (n=1; 1.7%), renal failure (n=1; 1.7%), volvulus (n=1; 1.7%), SD: Standard deviation, COPD: Chronic obstructive pulmonary disease, AF: Atrial fibrillation

Table 2. The comparison of ICU scores between the groups

ICU scores	Control group (x̄) ± SD (min-max)		Intervention group (x̄) ± SD (min-max)		p
APACHE II	17.3±3.9 (10-25)		16.8±4.0 (10-25)		0.61
GCS	12.5±1.9 (8-15)		13.8±1.1 (11-15)		**0.004**
	B	**Std. error**	**Exp (β)**	**Confidence interval**	**p**
RASS	-0.2	0.4	0.8	0.3-1.8	0.59

SD: Standard deviation, ICU: Intensive care unit, APACHE II: Acute physiology and chronic health evaluation II, GCS: Glasgow Coma scale, RASS: Richmond agitation sedation scale

development in the control and intervention groups was examined, it was observed that 86.7% of the patients in the control group and 26.7% of the patients in the intervention group developed delirium. This difference between the groups was found to be statistically significant (p=0.026) (Table 4).

Besides, the risk of developing delirium in the control and intervention groups was compared using the generalized estimation equations test. Accordingly, it is seen that the risk of developing delirium was 2.32 times higher in the control group compared to the intervention group, and this was statistically significant [β=0.84, SE =0.37, Exp. (β) =2.32 confidence interval =1.107-4.88, p=0.026].

Discussion

In the literature, it is stated that some chronic diseases such as hypertension, diabetes, and situations such as cardiac surgery and use of mechanical ventilation in addition to various medical and metabolic problems, contribute to the development of delirium (4-5,13,27-32). These situations were not taken into account in the selection of the sample, since it was preferred that the sample of the study consisted of the older ICU patients, and it was considered that there was at least one chronic disease in elderly patients and mechanical ventilation support was generally used in the intensive care setting. Nevertheless, no significant difference was found between the control and intervention groups in terms of socio-demographic and medical characteristics of the participants. This finding was evaluated as important in terms of the reliability of the study results and interpreted as the randomly formed groups were homogeneous.

Table 3. Comparison of the environmental factors of the ICU between the groups

	Control group ($\bar{x}$) ± SD (min-max)	Intervention group ($\bar{x}$) ± SD (min-max)	Total ($\bar{x}$) ± SD (min-max)	p
Temperature (°C)	24.2±0.4 (23.2-24.9)	24.1±0.6 (23.5-26.3)	24.1±0.5 (23.2-26.3)	0.06
Humidity (%)	33.5±4.8 (30.2-48.4)	35.7±4.5 (33-55)	34.6±4.7 (30.2-55)	**0.00**
Sound (dB)	56.3±2.6 (48.9-59.9)	50.31±2.1 (45.6-54.8)	53.3±3.8 (53.5-59.9)	**0.00**

SD: Standard deviation, ICU: Intensive care unit, dB: Decibel

Table 4. Comparison of delirium development frequency in control and intervention groups

	Delirium		
Group	**Yes n (%)**	**No n (%)**	**p**
Control group	26 (86.7)	4 (13.3)	0.026
Intervention group	8 (26.7)	22 (73.3)	
Total	34 (56.7)	26 (43.3)	

*The row percentage was calculated

The ICU scores of the patients were calculated since their admission to the ICU. APACHE II score was calculated by the intensive care physician and recorded in the patient file. We obtained this score from the patients' scale however, GCS and RASS scores were monitored daily. Therefore, repeated measurements were obtained for GCS and RASS scores, and the mean of these measurements was used in statistical analysis. GCS was significantly different in both control and intervention groups while there was no significant difference between the groups in terms of APACHE II and RASS scores. Accordingly, GCS scores were higher in the patients in the intervention group, and it is thought that this situation may cause the effect of environmental modifications in the ICU. Both control and intervention groups had no baseline GCS and RASS values since measurements were not made before routine care or study interventions were performed. In the study, the mean of repeated measurements for GCS and RASS into the day were analyzed. In addition, it was not possible to determine whether the baseline GCS and RASS values were similar in both groups, as attempts were made to partially provide orientation during routine care.

The fact that the APACHE II and RASS scores were not different supported that our sample indicated similar characteristics. In studies on the subject in the literature, whereas the APACHE II score was found to be associated with delirium (23,33), it was observed that GCS and RASS scores were not evaluated.

In our study, it was found that delirium developed in one of every two patients and this was statistically significant. McNicoll et al. (8) stated in their study that the frequency of delirium was 31%, this frequency was 40% in the intensive care period and reached 70% in the older patients. In other studies, were used CAM-ICU for delirium, it was observed that the frequency of delirium varied between 11-75.6% (9,11,34-36). These different results may be due to the characteristics of the sample or the different scales used to diagnose delirium.

The importance of environmental modifications such as temperature, light, and sound to prevent delirium in ICU is emphasized in some studies (8,37,38). In the study, despite taking the necessary precautions, the mean of sound level in the ICU exceeded the level determined by WHO for 40 dB (A) during the day and 35 dB (A) at night (39). However, similar to the literature (16,40), reducing the sound level decreased the risk of delirium.

In the study, the effect of temperature level on delirium could not be examined very well since the temperature level in the ICU was controlled centrally while minimal temperature changes were determining between control and intervention groups. Unlike this result, although the humidity level was between 30-60% in line with the recommendation of WHO and the difference was no much more in both groups a significant relationship was found between the humidity level and delirium. The seasonal indoor humidity difference was related to the outdoor temperature, thermal insulation properties, and heating-ventilation systems of the hospital building. In the literature, many studies examining indoor air quality and low humidity recorded dry air or low humidity induce some skin, eyes, and airways problems, fatigue, infection, decrease sleep quality, and vocal fatigue (41,42). Sunwoo et al. (41) stated that the thermal comfort in the elderly was lower at low humidity levels than in the young. However, the effect of humidity level on delirium was examined for the first time in the current study. The findings from our study may arise from other variables/interventions evaluated in the study or sleep quality and/or thermal comfort related to relative humidity. Although it needs to be explained with specific experimental studies, it can be suggested to consider that the risk of delirium development may be high in patients in ICUs in autumn and winter months when humidity is lower. In our study, it was determined that there was a significant difference in terms of sound and humidity in the groups. As emphasized in the literature, it was also found that many attempts to control environmental stimuli reduced the delirium risk by 2.32 times.

Continuous lighting in ICUs causes the patients to lose their sleep-wake cycle. The natural light in caring environment, which nightingale also attaches importance to, can help patients correct their innate circadian rhythm and help them recover. However, ICUs are areas where daylight is insufficient and artificial lighting is preferred (43). Some studies stated that light treatment could be effective to prevent delirium (14,40,44-46). Adjusting the lighting environment is a non-invasive procedure that can improve the patient's quality of life without disturbing the medical care of the patient and reduces the duration of hospital stay (14,46). Since the effect of integrated landscaping on delirium was examined in our study, the effect of bright light application on delirium was not evaluated independently. However, indirectly, it can be said that it prevents the development of delirium together with other physical landscaping and practices aimed at providing stimuli.

Study Limitations

The study has some limitations. The sample study constituted of the non-complicated and non-randomized elderly patients in the ICU. Also, it was necessary to collect the data of the control group in the autumn and winter, and the data of the intervention group in the summer. Since we consider the seasonal humidity changes based on the previous ICU records. In both groups, we included every patient who met the sampling criteria until we reached the number of samples specified according to the power analysis. However, it can be said that the patients' similarity in terms of socio-demographic and medical characteristics increases the power of the study. In this study, the sleep quality of individuals was based on subjective reports of the patients, and the lack of use of any objective scales can be considered as a limitation of the study. However, in the study, the effect of humidity level on delirium was evaluated by using seasonal differences instead of using an ambient humidification device. In this study, the effect of environmental modifications on preventing delirium the elderly patients in the ICU are considered in combination. Hence, this study may shed light on the planning of various studies to examine the relationship between humidity and delirium.

Conclusion

In conclusion, there was no significant difference in terms of socio-demographic and medical characteristics of the patients in the intervention and control groups participating in the study. It was determined that GCS score and humidity level were higher and the sound level was lower in the intervention group. Delirium frequency and risk were reduced in improved ICU conditions.

In this study, the risk of developing delirium in older ICU patients can be reduced by a specific care bundle that include using calendars and clocks, ensuring that the environment is less noisy, allowing to use glasses or hearing aids if patients had and bright light intervention which are among important nursing initiatives.

Acknowledgments: We thank to Res. Assist. Merve Basol in order to consult for statistical data analysis.

Ethics

Ethics Committee Approval: Ethical approval was obtained from the Ethics Committee of Bolu Abant İzzet Baysal University Human Research in Social Sciences (2017/9).

Informed Consent: Written permissions were obtained from the hospital administration for the application of the study, and from patients and/or patient relatives with the informed consent form.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Concept: A.A., A.K.Y., Design: A.A., A.K.Y., Data Collection or Processing: A.A., Analysis or Interpretation: A.A., A.K.Y., Literature Search: A.A., A.K.Y., Writing: A.A., A.K.Y.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: This study was supported by Bolu Abant İzzet Baysal University Scientific Research Projects Unit (project number: 2017.13.01.1234)

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