Determination of Factors that Cause Noise in Intensive Care Unit Environment

Yoğun Bakım Ortamında Gürültüye Neden Olan Faktörlerin Belirlenmesi

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ABSTRACT Objective: This study was conducted for determining the factors that cause noise in an intensive care unit (ICU). **Material and Methods:** The research was designed as a prospective, non probabilistic sample method to determine the factors cause in ICU. Between May and July 2012, a total of 50 consecutive patients who were over 18 years and had open heart surgery at the Cardiovascular Surgery Intensive Care Unit (CVSICU), Maslak Acibadem Hospital (Istanbul, Turkey) two months period were included the study. The noise intensity was measured by a device detects sound waves between 30-130 decibel (dBA). **Results:** Forty three patients of total fifty patients expressed the CVSICU was noisy. The daily mean noise intensity was measured in 67,42 dBA, at nights 64,76 dBA and 70,08 dBA at daytime. It was stated the most of the complaints about the noise was related to monitor alarms. The mean noise intensity due to the monitor alarms was measured in 101,7 dBA. Other causes of noise were listed as door and telephone rings, IV pumping noises and noise of the staff, respectively. **Conclusion:** In this study; it was determined that ICU environment was noisy, monitor alarms were the main noise source and noise caused changes sleep habits of patients. In order to overcome these problems, it's suggested that technologies might be developed enable monitor alarms can be only heard by related staff, deck telephones may only be heard by health professionals via activating vibration systems and unnecessary communications should be avoided.

Key Words: Noise; voice, transportation

ÖZET Amaç: Bu çalışma yoğun bakım ortamında gürültüye neden olan faktörleri belirlemek amacıyla tanımlayıcı olarak yapıldı. **Gereç ve Yöntemler:** Araştırma, yoğun bakımda gürültüye neden olan faktörleri belirlemek amacıyla olasılıksız örneklem yöntemiyle prospektif olarak planlandı. Mayıs ve Haziran 2012, iki aylık süreyi kapsayan tarihlerde, Maslak Acıbadem Hastanesi Kalp Damar Cerrahisi Yoğun Bakım Ünitesi'nde (KVCYBÜ) (İstanbul/Türkiye) 18 yaş üzeri ve açık kalp ameliyatı olan 50 hasta çalışmaya dahil edildi. Gürültü şiddeti 30-130 desibel (dB) aralığındaki sesleri algılayan bir cihaz ile ölçüldü. **Bulgular:** Hastaların %86'sı yoğun bakım ortamının gürültülü olduğunu ifade etti. Günlük ortalama gürültü şiddeti 67,42 dB, gece 64.76 dB ve gündüz 70.08 dB olarak belirlendi. Gürültü yakınmalarının başında monitör alarmlarının geldiği saptandı. Bu nedenle ortaya çıkan gürültü şiddetinin 101.7 dB olduğu saptandı. Diğer gürültü nedenleri arasında sırasıyla kapı ve telefon sesleri, intravenöz pump sesleri ve çalışanların sesleri yer aldı. **Sonuç:** Bu araştırmada yoğun bakımda gürültü gerçeğinin süregeldiği ve en önemli sorumlunun monitör alarmları olduğu, gürültünün hastaların uyku düzenini bozduğu belirlendi. Bu problemlerin üstesinden gelebilmek adına monitör alarmlarının sadece ilgili çalışan tarafından duyulabileceği teknolojilerin geliştirilmesi, telefonların sadece sağlık profesyonelleri tarafından duyulabileceği şekilde tasarlanması önerilmektedir.

Anahtar Kelimeler: Gürültü; ses, iletim

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Many medical technological devices are used in intensive care unit (ICU) for diagnosis and treatment. Many of them cause unignorable noise.[1] In addition, hygienic care, bathing, feeding, aspiration, the other devices used during care as well as sound of phone calls can raise the volume even more that should be between 35-40 dBA is published by World Health Organization (WHO) in hospital environment.[2] Uncontrollable noise in ICU effects patients negatively both physically and psychologically and also may retard the healing process.[3] On the other hand in the recent studies effects of noise was detected on sleep and cardiovascular system.[3] Nurses play a key role on reducing physical, psychological and social stress where patients exposure at intensive care units and presenting health care integrated with progressive technology. ICN theme was ''Positive Practice Environments'' (Quality Workplaces=Quality Patient Care) in 2007. Intensive care nursing (ICN) is clear that a safe work environment in the health sector significantly contributes to patient safety and support positive patient outcomes. The goal of ICN's call for positive practice environment is to improve the quality of health services through health care work environment that support performance excellence.[4] Development of holistic health care and presenting in accordance with patient needs, reduction of other factors that cause stress especially like noise and avoiding destruction will speed up the healing processes.[3] In this study, severity and causes of the noises were investigated in a cardiovascular surgery (CVS) ICU. It was demonstrated to reveal the current situation and create a base for similar works. Also the results was not generalized to the population.

OBJECTIVE

This study was conducted for determining the factors that cause noise in an ICU.

MATERIAL AND METHODS

This study was started after obtaining ethical institutional approval by Acibadem University. After obtaining institutional approval and informed consent by Acibadem University; this study was conducted in a 9 bed-ICU of CVS between May-July 2012. Patients (n=50) aged over 18 years, conscious, oriented and cooperated after extubation were accepted for the study. Patients who were accepted to ICU without the respiratory support and a plan to be discharged in 3-4 hours following procedure excluded from the study in order to provide a more homogenous patient population.

Data in this study were collected via two ways: Data Collection Form for Evaluation of the Factors that Cause Noise in ICU and Noise Levels Record.

Data Collection Form included 15 questions about socio-demographics and environmental nature of noise such as number of ICU patients, length of stay in ICU, caregivers and nurses, working time and patients' educational background and Noise Levels Record included the data about the level of the noise. Intensity of the noise was measured 1 meter above the ground and 1 meter away of patients with a device (Testo-815, Carlsbad, CA) which can detect 30 to 130 range decibels (dBA) of sound and records mean values for half an hour intervals.

The data obtained from the device was recorded to Noise Levels Record. Noise sources were recorded as mean of violence in the last 30-minutes period by using this feature of the device. All these measurements were made according to specified user guide information of the device and placed 1 meter above the ground, 1 meter away of patients and factors that cause noise. Measurement of noise was started immediately after admission of patients to ICU and continued till the decision of discharge was taken. So, level of noise was recorded in every half an hour during patients' length of stay in ICU. Noise Levels Record was constituted of data obtained from the measurement device before the patients were transferred to ward. Information of noise severity records was not given to employees during the measurement.

Predictive Analytics Soft Ware (PASW Statistics 18, IBM Corporation, NY, US.) was used for statistically analysis. Dichotomous results were given in percentages. Continuous data were given as mean standard deviation. To compare dichoto-

mous data, Chi- square and Fisher Exact Tests were used. Student-t Test was used to compare continuous data. The accepted level of significance for all analyses was $p<0.05$.

RESULTS

There were 32 male patients (64%) and the mean age was 58.5 (±13) years (range: 19-82). There were 32 patients (64%) had isolated bypass surgery, 5 patients (10%) had valve surgery and 5 patients (10%) had aorta surgery. 8 patients (16%) had other cardiac surgery procedures. Other sociodemographic and disease characteristics of the patients were given in the (Table 1).

According to Data Collection Form, mean duration of intubation and post operative length of stay in ICU were 8.5(±5) hours (2-33) and 28.3 hours (range: 12-109), respectively. In mean, daily 3.1 patients were admitted to ICU and 2.9 healthcare workers worked in this while.

Eighty six percent of the patients complained of the noise through their stay at ICU and 72% of them stated that the monitor alarms were the most important reason of the noise. Noises originating from monitor alarms, warning other patients and air conditioning systems had the highest rate of noise (101.7 dBA, 97.9 dBA, 93.1 dBA). As the most noisy sources that cause noise in intensive care environment expressed by patients were determined according to statistical results. All the noise intensity of noise source were calculated with measurement mean of the highest noise intensity once per patient. The other noise sources were presented in the (Table 2).

Mean of noise intensity was 67.4 dBA (standart deviation: 14) in the daytime. Mean of the period of healthcare workers day shift was 70.1% (standart deviation: 15) and the leading term of noise intensity. The other mean noisy times and the intensity of noise were presented in the (Table 3).

According to noise effects on patients, 32 patients (64%) expressed changes on sleep habits and 11 patients (22%) expressed physiological changes. The other noise effects on patients were presented in the (Table 4).

TABLE 1: Sociodemographics and disease characteristics (n=50).

Variables	n	%
Gender		
Female	18	36
Male	32	64
Average Age	**58.5±13**	
Educational Status		
Primary school	18	36
High school	20	40
University	11	22
Other	1	2
Occupation		
Self-employed	19	38
Housewife	13	26
Doctor	2	4
Teacher	2	4
Other	14	28
Diagnosis		
Coronary Artery Disease	33	66
Valve Disease	6	12
Aorta Disease	4	8
Other	7	14
Operation		
Isolated Bypass Surgery	32	64
Valve Surgery	5	10
Aorta Surgery	5	10
Other	8	16
Patients with previous surgery history	27	54
Patients without previous surgery history	23	46
Patient with previous ICU history	12	24
Patient without previous ICU history	38	76

ICU: Intensive care unit.

According to sociodemographic variables and sources of noise; statistically significant differences were found between patients educational status and monitor alarms ($p=0.008$). Patients with higher educational graduate were less irritated from the monitor alarms that are shown in the (Table 5). However, no significant differences were found-between- age, sex, occupation and noise complaints as well as noise causes ($p=0.008$-$p>0.05$).

DISCUSSION

While developing health care technologies have contributed to the patient care, it has also brought some problems such as patient and staff safety and

TABLE 2: Noise sources of ICU (N=50).

Noise sources	Number*	Percent**
Monitor alarms	36	72
Warning other patients	28	56
Telephone ring	25	50
IV pump sounds	21	42
Doors opening or closing	20	40
Conversation among staff/cellular phones	18	36
Noise of other patients	15	30
Other patients visitors	15	30
Removing garbage, medical waste	15	30
Air condition	10	20
Pneumatic system	9	18
Shift exchanges of nursing staff	9	18
Cleaning or sweeping	9	18
Opening medical equipments	7	14
Talking with patient's family members	7	14
Throwing bottles/ Falling objects	5	10
Oxygen system/ Blood gas equipment	5	10
Paper napkins machine	4	8
Patients admitted emergency	2	4
Noise of vacuum cleaner	2	4

* Multiple answers were given.

** Percentages were calculated on the sample and the number of line.

TABLE 3: Mean noisy times and noise intensity.

Variables	Mean (dB)	Standard deviation
Daily noise intensity	67.4	14
Night shift noise intensity	64.8	14
Day shift noise intensity	70.1	15
Staff entering or leaving noise intensity	68	12

TABLE 3: Mean noisy times and noise intensity.

Variables	Number	Percent
Patient express changes on sleep habits	n=32	64
Frequent awakening	24	48
Difficulty in falling asleep	5	10
Not sleep	3	6
Patients express physiological changes	n=11	22
Palpitation	3	6
Irritability/Agitation	8	16

noise.[5] The World Health Organization has published a guide in order to control the noise and minimize the effects of noise on patient health. Maximal noise intensity during the daytime was represented as 40 dBA and 35 dBA during the night-time according to this guideline.[6,7] As a result of the measurements, mean noise intensity was found as 67.4 dBA in the cardiovascular surgery ICU where the present study was performed. Moreover, 86% of the patients stated that intensive care unit environment was noisy.

In the study by Lawson et al. was reported that mean day time noise level was 85 dBA.[3] In another study it was reported that daily noise level changed 41 dBA and 61 dBA at hospital environment.[8] In the study Khademi et al. was reported daily noise level was reached 94 dBA and mean daily noise intensity was 60.2 dBA.[9] So, the results from this study on daily noise levels were shown that there are similarity with other studies in literature.

In this study, we found that mean noise intensity was 64.8 dBA at night-time and 70.1 dBA during the daytime which is approximately twice of the WHO's recommendation. However, in many studies it was discussed that the noise may have adverse effects both physically and psychologically and may also cause several problems such as discomfort, agitation, anxiety, difficulties in meeting the patients' daily activities, suppression of the immune system and changes on sleep habits.[10,11] We think that the negative effect of the noise on recovery process of the patients at ICU could be investigated in another study.

The unit where this study was performed is an open intensive care due to it's physical structure. There were 6 beds at the forepart and 2 beds at the back which are located alongside and separated with a curtain and a closed isolation room next to this unit. Considering that number of mean daily patients are 3,1, the patients are treated at the

TABLE 5: Assesment of patients' education level and noise sources.

	Disturbed		Undisturbed	
Variables	n	%	n	%
Monitor alarms				
Primary school graduated	15	41.7	3	23
High school graduated	17	47,2	3	23
University graduated	4	11,1	7	54

forepart section of the unit. There is a door inside which is opened to the surgery unit and one other door to be used in order to inform patients' relatives, transfer of the patients and provide medical equipments. That's why there are 2 separate entrance and exit doors. Ventilator, monitor and pumps located fixedly at bed head are used and are renewed at every 24 hours and patient's needs by taking the physiologic requirements of patients into consideration. One nurse works per a patient. Mean daily number of patient is 3,1 and mean number of nurse is 2.9. All these properties may have effect on the increase of noise intensity.

In the studies by Juang et al. and Li et al. reported that the noise originating from medical devices was 59,1% and 48.3% respectively in their studies.[12,13] In an other study conducted by Lawson et al, it was stated that 56% of the noise source was alarms resulting from the devices at the ICU.[3] In another study, medical devices were indicated as a source of noise, especially ventilation system, bedside infusion pumps and monitor were reported noise sources.[14] In our study, we found that major cause of the noise was monitor alarms, 36 of total 50 patients (72%) were uncomfortable due to noise of these devices and the noise intensity was measured as 101.7. Results of these studies in the literature were shown similarity with results about medical devices as a noise sources of the unit where this study was performed and supported in terms the factors that cause noise. In order to prevent the noise pollution, therefore, parameters according to the patient profiles should be monitored, lower and upper alarm limits according to the patient clinics should be arranged and by taking into consideration the patient safety, alarm intensity should be at audible level.

Intensive care unit is known where noise pollution is maximum in many cases due to bedside ventilation and monitor systems, infusion pumps and alarms, telephone and door rings, conversation of staff bedside, emergency situations' organization and talking with patients' family members.[11,15] It will be useful to remember ICN theme about quality workplaces again. Based on the conviction, supported by evidence, that quality health care workplaces provide quality patient care, ICN has launched a global call to address and improve the serious deficiencies currently existing in the health work environment in all regions. The delivery of safe, high quality and efficient health services depends on the competence of health workers and a work environment that supports performance excellence. The ongoing underinvestment in the health sector in many countries has resulted in a deterioration of work conditions. This has had a serious negative impact on the recruitment and retention of health personnel, the productivity and performance of health facilities, and ultimately on patient outcomes. Positive practice environment must be established throughout the health sector if national and international health goals are to be met. ICN has brought this issue to light on the occasion of International Nurse Day, with the publication of an information and action toolkit entitled, ''Quality workplaces=quality patient care''.[4]

Akansel et al. in their study, on extubated patients after coronary surgeries at the cardiovascular surgery ICU, indicated the other patients' warnings to make coughing exercises by a nurse as the source of noise and ratio was 85.7%.[16] In the present study, rate of other patients' warning was 56%.[17] Location of beds closely to each other depending on the interior design of ICU, separation of beds by curtains instead of compartments or doors, audible notices by other patients could be basis for noise. Making arrangements inside of ICU and designing of area specifically according to the patient will contribute to less spread of warnings for other patients in the environment. All those will provide to have less disturbing factors, relaxing of patients and meeting physiological requirements such as sleeping.

In the present study telephone and door rings were presented as a most complaints factors that cause noise.[18] In the study by Akansel et al. telephone ring was reported rate of 54.3% as a noise source. In another study by Vehid et al. was reported telephone was rate of 46.7% and door ring was rate of 41.6% as sources that cause noise.[16] In this study, noise ratios originating from phone and door rings were 50% and 40%, respectively. The mean intensity of these noise source was measured

correspondingly as 89.9 dBA and 93.1 dBA. The phone and door rings were mostly heard after admission of patients into ICU. The reason why phone and door rings were sources of noise could be explained as curiosity of the patient relatives related to the surgery and information requirements about the condition of the patient. Informing relatives of the patient, providing meetings of patients with their relatives at appropriate time intervals, promoting the patients' relatives on whatever they would like to ask and learn, paying attention to the use of comprehensible and definite expression are some of the recommendations made.

In the previous studies, it was indicated that changing of the guard in ICU created the most noisy environment. In another study in the literature it was reported that changing of the guard was in 3 of 15 factors causing the noise.[17] In our study, mean value of the noise intensity was measured as 67.95 dBA during the changing of the guard. Transferring necessary information related to the patients briefly and changing of the guard at audible level (not a level that disturbing patients) will help to prevent a noisy environment. Akansel and colleagues reported that 37.1% of factors causing noise were staff voice and 60% were conversation of staff with each other at the bed head in ICU.[16]

In the present study, the patients stated that pneumatic (18%) and ventilation systems (18%) as two source of the noise in ICU. The noise intensity of the ventilation and pneumatic system were measured as 63.5 dBA and 84.3 dBA, respectively. The ventilation system in ICU was closed for a short time and measurements were made. When all other noise causing factors were removed at ICU, the noise intensity was measured as 48.3 dBA. Even all noise causing factors are removed, the noise intensity of the ventilation system itself (63.5 dBA) explained why the intensive care environment was noisy. Any result was found related to the pneumatic system. The pneumatic system is actively used at all hospitals including ICU where the present study was performed. Besides from its advantages such as convenience, time saving and less manpower, fall of tube from the system may wake the patients up and create sleeping problems.

Intensive care units are departments where care is given to critical patients. Using devices on critical care and invasive procedures cause complex and noisy environment and sleep disorders.[11] Sleep disorders were reported as complaints mostly by the patients had experienced ICU before.[18] In another study sleep disorders were reported as a source of stress.[19] In the study, 61% of patients were taken to progressive care unit from ICU, had sleep disorders, 7% of these patients had insomnia and 44% of these group patients had sleep disorders during 3 months after discharge.[19] Correlation was reported between sleep disorders and many syndromes as confusion and psychosis.[20] In another study, it was reported sleep disorders occurred during ICU stay causes posttraumatic stress disorders after discharge.[6] In this study, 12 patients (24%) had previous ICU experience. When patients having sleep changes due to noise were examined, it was reported that 64% of them experienced changes in their sleep. It was observed that 48% of patients had problems with frequent awakenings, 10% of patients had difficulty in falling asleep and 6% of patients did not sleep. Whether noise at the intensive care unit could be the source of sleep problems of patients in ICU and then in postoperative wards may be a topic of another study.

In previous studies, it was reported noise effected humoral and cellular immunity, increased catabolism, got depression on respiratory system with muscle dysfunction and increased heart rate and blood pressure with sympathetic activity.[21] In this study, it was reported 3 patients (6%) expressed palpitation and 8 patients (16%) expressed irritability/agitation. This study results supports the other studies in the literature about effects of noise on sleep.

Relation between the sources of noise and their correlations with the sociodemographic properties (age, profession, gender and education) was also investigated in our study. No statistically significant difference between noise sources and age, profession and gender was found ($p>0.05$). However, when compared to the educational level, 41.7% of primary school, 47.2% of high school and 11.1% of university graduated patients noted mon-

itor alarms as source of the noise ($p<0.05$). According to this statistical results, the reason why the ratio of university degree patients are less than other graduated ones can be explained that the university degree patients are aware of necessity of alarms for their needs and do not perceive the alarms as sources of the noise.

However, our study has number of limitations and the results may not be generalize. A limitation of this study is that the numbers of patients were relatively small. The study was conducted in an educational center and trainees (both nurses and medical students) were around at the research time that may affect the results. The ICU was designed for cardiovascular surgery and has many devices, which have alarming systems such as IABP (intraaortic balloon pump), dialysis machine, high parameter measuring monitors etc. may not reflect the standart ICU environment.

CONCLUSION

As a result, the noise intensity at the ICU where this study was performed exceeded WHO guideline. It was observed that monitor sound caused the most intensive noise, followed by door bells, phones and loud conversation of staff. Developing technologies of which only related staff could be able to hear the monitor alarms, designing phones of which only health professionals could hear, increasing awareness among staff and organizing trainings to develop health professionals' attitudes and behaviors are some of the recommendations.

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