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EVALUATION AND ANALYSIS OF NOISE LEVELS IN HOSPITALS: A PRELIMINARY INVESTIGATION

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Creating a healing environment is important for hospital care and increasing attention has been paid to the ambient health care physical environment, including effects of the sensory stimuli such as sound. In this study, a preliminary investigation of the acoustic environments in the waiting areas in hospitals was conducted. The aim of this study was to clarify the actual conditions in two waiting areas in two hospitals in Kuala Lumpur, Malaysia. The investigations consist of both noise level measurements and questionnaire surveys. At first, measurement of noise levels were recorded over an eight hour period and converted into different levels (L_{Aeq} and L_{Amax}). In general, noise levels for both hospitals are strongly influenced by noise produced during general activities in waiting areas. It was found that the noise level L_{Aeq} in all waiting areas measured exceeded the recommended levels. Then, respondents were interviewed in the course of a questionnaires survey dealing with nuisance occasioned by noise sources during respondent's waiting time. The survey results in both waiting areas in two hospitals also support the measurement results. This paper gives a fundamental data for the help of future refinements.

1. Introduction

State of knowledge of evidence based design of health care has grown rapidly in recent years. The evidence shows that well-designed physical setting plays an important role in making the hospital safer and more healing for patients and better place for employees to work. Noise in hospitals is important for the obvious issue of annoyance especially to the patients. There is evidence that shows sources of noises can contribute to stress in hospital staff and patients[1, 2]. However, a few numbers of researches from over the world have been done[1-7] to analyze and overcome this matter even though it ranks among the top complaints of hospital patients, visitors, and staff. The studies of acoustical environment in Malaysian hospitals also are still very rare.

Although acoustics element is one of the factor in achieving indoor environmental quality (IEQ) and an important element in creating a workable environment, it is often neglected by designers and architects. Acoustical environment could either enhance or damage a person's productivity. Noise pollution has been found unacceptably high in operating theatres, standard patient's room, intensive care units, but also in the waiting areas. The effect may not only affect the patient's well-being and comfort, but may also cause stress for the staff, decreasing work performance and increasing anxiety. The hospital sources of noise are such as HVAC noise, announcement by speaker,

and moving parts of medical equipment are all important as are the frequently human activities among staff members and visitors.

In the meantime, Malaysia has the planning guidelines for environmental noise limits and control[8] published by Department of the Environment, as well as the one that have been implemented abroad[9].

In order to aim as fundamental data for the help of future refinements, two kinds of surveys i.e. measurement and questionnaire were conducted in two selected waiting areas focusing on a quantitative study on the noise level and observing the noise sources in two Malaysian hospitals.

2. Methodology

First stage of this investigation was the selection of sample as representatives for hospital's waiting area in Malaysia. In this study, two waiting rooms of two hospitals have been selected as our measurement subjects for assessment of the noise level during the daytime. The selection based on the following: general information of hospital and building accessibility. Although the materials, shapes and the volume of the rooms give significant effects to the acoustical quality but these were not taking strictly into consideration in our first stage of study. Actual capacities of each waiting room are expected to increase if all areas were occupied by incoming visitors in morning session.

2.1 Physical measurement

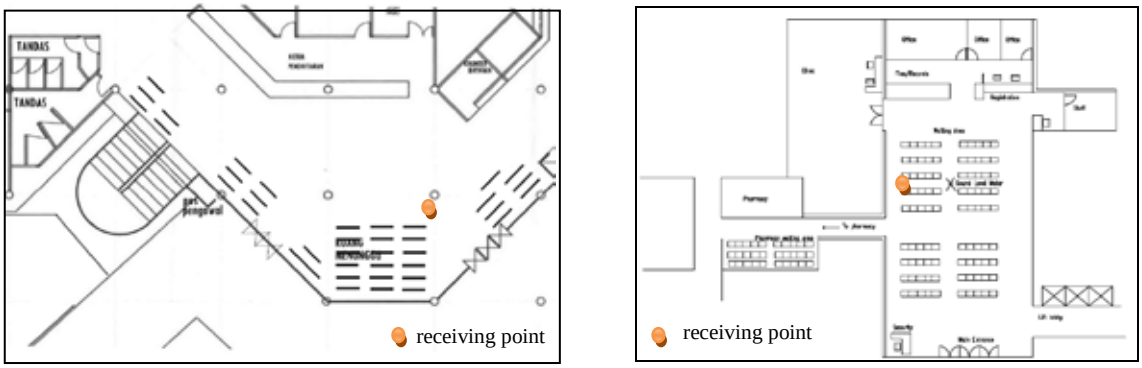
Noise levels were measured in the waiting areas of outpatient department of A- and B- Hospital. Both hospitals are a general hospitals located at Klang Valley area, Malaysia. Both hospital waiting areas are located on the ground floor. Figure 1 shows the plan of waiting areas and receiving points of measurements for both hospitals. Figure 2 shows the conditions of field measurement in both hospitals. The sound level meter (01dB SOLO Metravib) is used and located 1.2 m above the floor surface to measure the sound pressure level [dB(A)]. Time length every 10 sec is employed and a series of sound pressure level are extracted using commercial software (dBBATI32). So as to provide compact presentation and ensure convenient to the reader, the sound pressure level, both L_{Aeq} and L_{Amax} are calculated in the each 10 minutes interval.

2.2 Questionnaire survey

Questionnaires survey terms are shown in Table 1. As for survey content; five-step rating was employed for the evaluation. For the survey method at both hospitals, we decided to distribute the questionnaires at the seating positions of the respondent and collect after the questionnaires were filling up.

Table 1. Questionnaire survey items

1.	Respondent individual characteristics
2.	Level of importance of the subjects in waiting area
3.	Level of satisfactions of the subjects in waiting area
4.	Overall evaluation of waiting area
5.	The level of sound trouble in waiting area
6.	The difficulties to selected subject
7.	Overall evaluation on sound environment in waiting area
8.	Visit frequency and purpose



(a) Hospital A (b) Hospital B

Figure 1. Plan of the waiting area and receiving points of measurements

(a) Hospital A (b) Hospital B

Figure 2. Photo of field measurements in both hospitals

3. Results and discussions

3.1 Physical measurement

The noise level in Hospital A‘s waiting area was measured for 8 hours daytime at point illustrated in Fig. 1(a) and the result shown in Fig. 3. Figure 3 also shows the numbers of people in waiting area and announces counted during the daytime. Furthermore, the noise levels in Hospital B’s waiting area were measured for only 7 hours daytime at point illustrated in Fig. 1(b) and result shown in Fig. 4. However, the number of announces was not counted in Hospital B.

The noise level measured, L_{Aeq}, in a waiting area in Hospital A was exceeded from the recommended waiting area design sound level of 50 dBA. Furthermore, the fluctuation of L_{Aeq} is corresponding with the number of the people and announcement. The higher number of people and announcement strongly affect the measured sound pressure level, both L_{Aeq} and L_{Amax}.

Same basic tendency was found in Fig. 4. The agreement found in Hospital B can be considered having same agreement with Hospital A based on the higher number of people corresponds with that of the tendency of the sound pressure level. In addition, higher L_{Amax} in Hospital B is observed in Fig. 4, whereby the maximum level is approximately 94 dBA.

3.2 Questionnaire survey

Questionnaires are distributed randomly to a group of patients, visitors and also hospital staffs that are age ranging from 15 to 60 years old and above. The number of respondents is 159 people in the Hospital A’s waiting area and 25 people in the Hospital B’s waiting area.

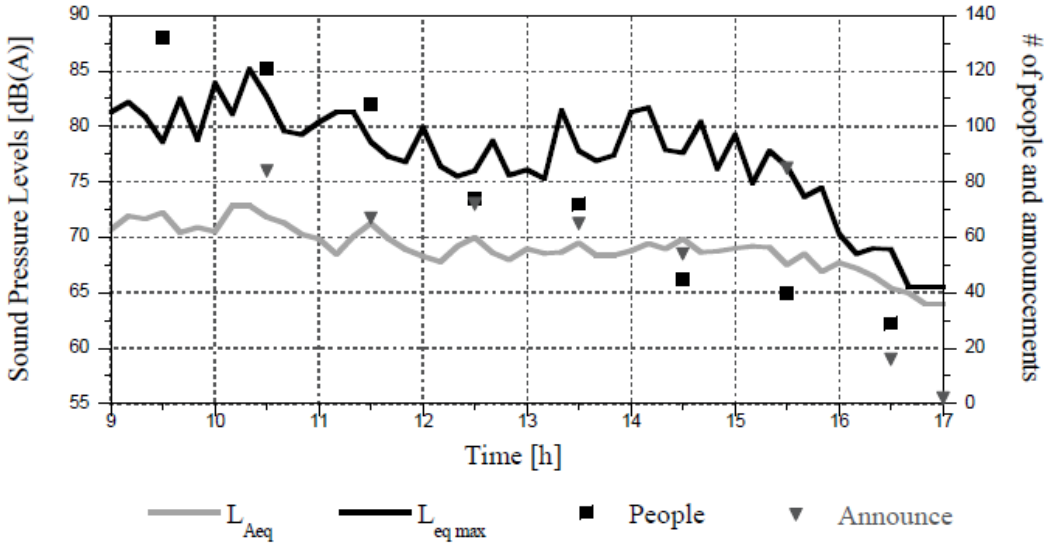


Figure 3. Sound levels and the numbers of people and announce in waiting room's Hospital A

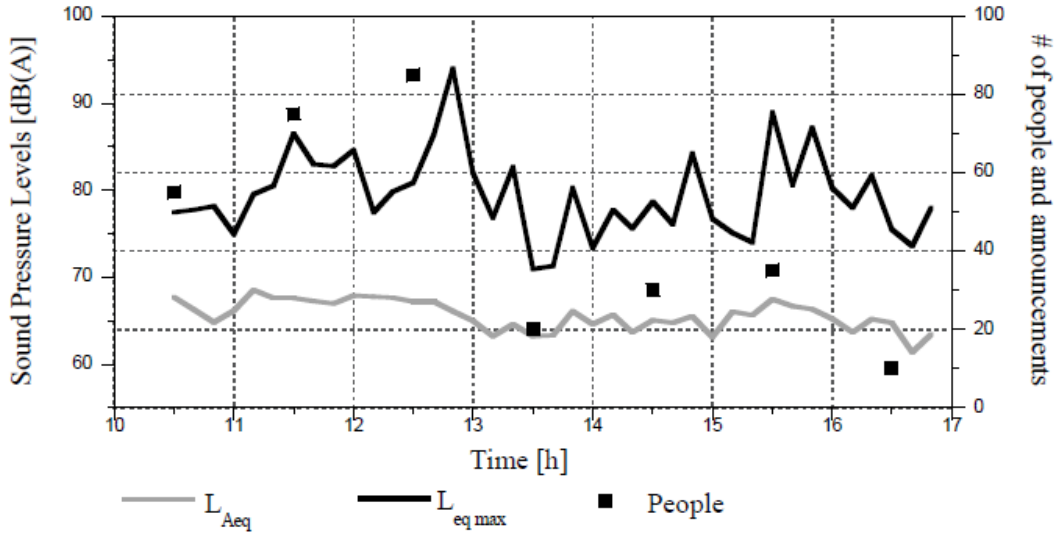
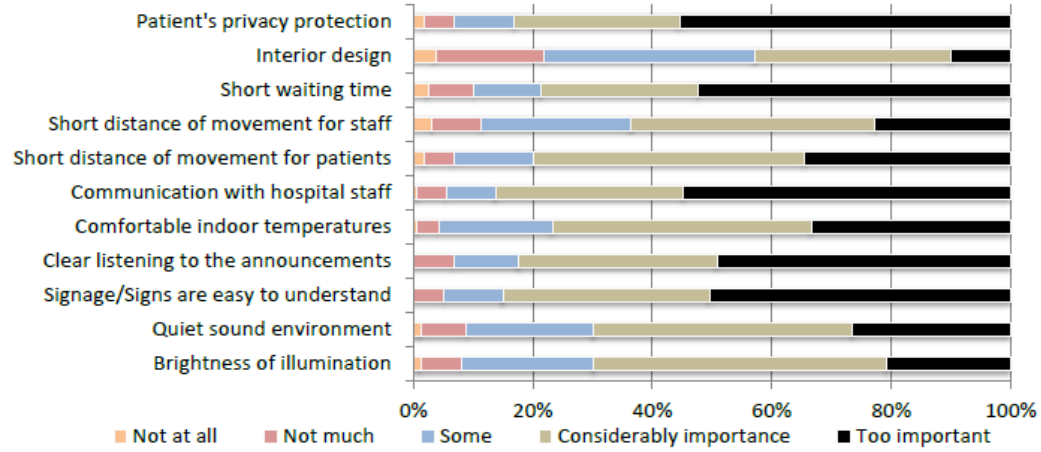


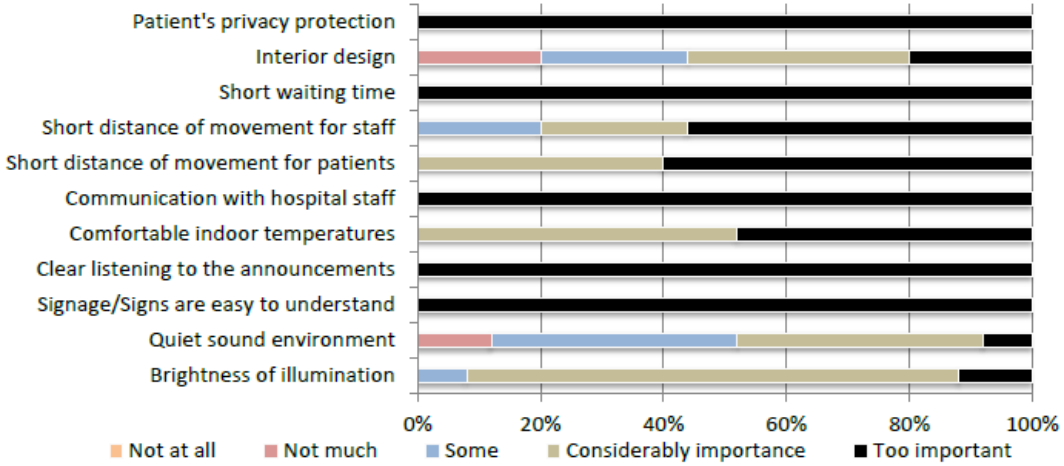
Figure 4. Sound levels and the numbers of people in waiting room's Hospital B

The highest age group of the respondents in Hospital A's waiting area are between 20 to 30 years old, which is 43%, followed by 23% age between 30 to 40 years old. 47% of the respondents are male and 53% are female.

The overall subject evaluation on current situation in waiting area is shown in Fig. 5(a) The subject on quiet sound environment is same importance with brightness of illumination subject. However, majority of respondents have minimal satisfaction with the subject of quite sound environment in waiting area as observed in Fig. 6(a). In Fig. 7(a), from 159 respondents, 6% think the overall environment is too noisy, 22% think the environment is considerably noisy and 45% think it's quite noisy. Human activities have been identified as a most contributing factor of noise sources. Figure 8(a) shows 4% of respondents were definitely having difficulties in hearing the announcement, while another 8% were always having difficulties in hearing the announcement. Furthermore, 4% were definitely have experience difficulties in making conservation, while 5% always have difficulties and the other 46 % seldom having difficulties to make conversation.



(a) Hospital A



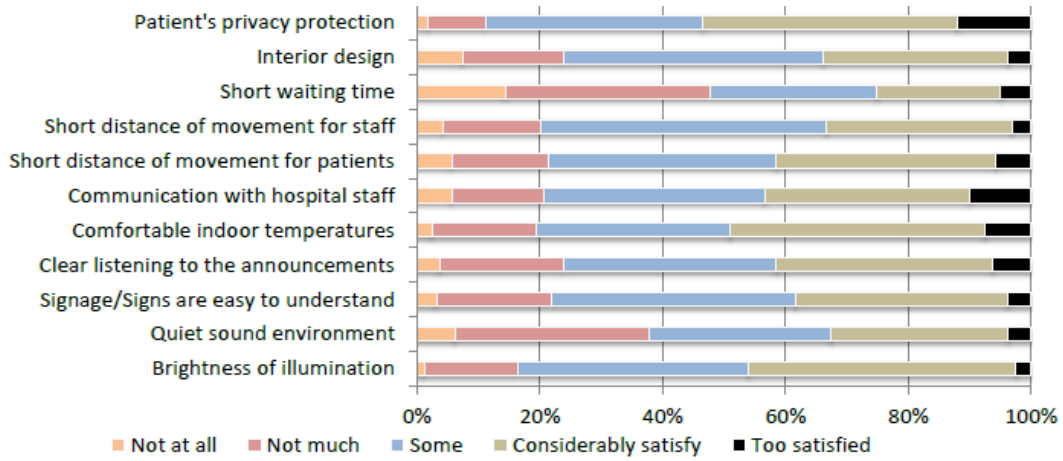
(b) Hospital B

Figure 5. Level of importance for the survey's subject in both hospitals

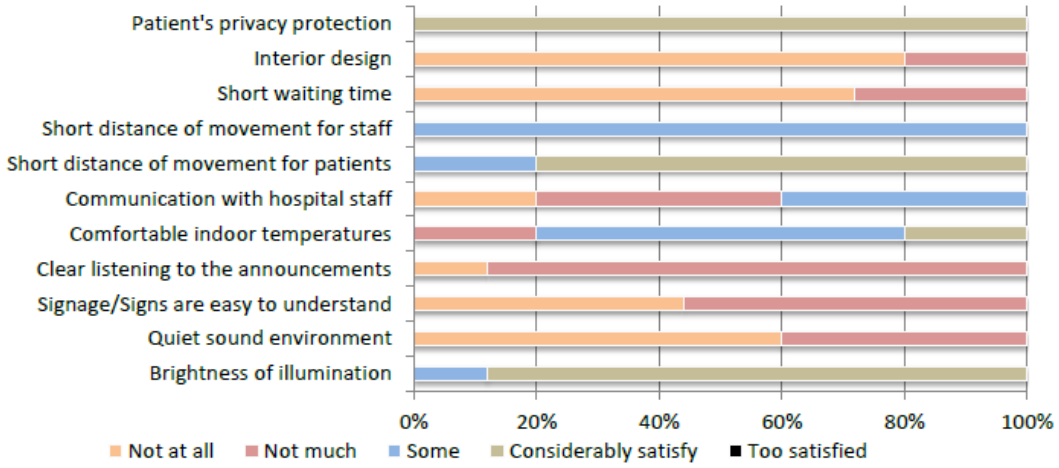
Meanwhile, based on the survey in Hospital B, the highest age group of the respondents are between 40 to 50 years old, which is 36%, followed by 32% age between 50 to 60 years old. Apart from that, 60% of the respondents are male and 40% are female. In Fig. 5(b), the overall subject evaluation on current situation in waiting area showed the tendency of importance is higher, but the quiet sound environment subject is lower than others. Nevertheless, result from level of satisfaction shown in Fig. 6(b) shows contrary which is majority of respondents are not satisfied with the subject.

In spite of that, overall situation in Hospital B's waiting area is slightly poor than Hospital A's waiting room. From 25 respondents, 44% think the environment is too noisy, 36% think the environment is considerably noisy and 20% think it's quite noisy. The contributing factors in this waiting area having similar weightage between human activities and machinery noise as shown in Fig. 7(b). In Fig. 8(b), 56% of respondents were always having difficulties in hearing the announcement, while another 44% were sometimes having difficulties in hearing the announcement. Moreover, 60% have experience always difficulties in making conservation, while 20% sometimes have difficulties and the other 20 % seldom having difficulties to make conversation.

The survey results in both waiting areas in two hospitals also support the measurement results: it can be said that many of the noise are mainly generated by people in the waiting area.

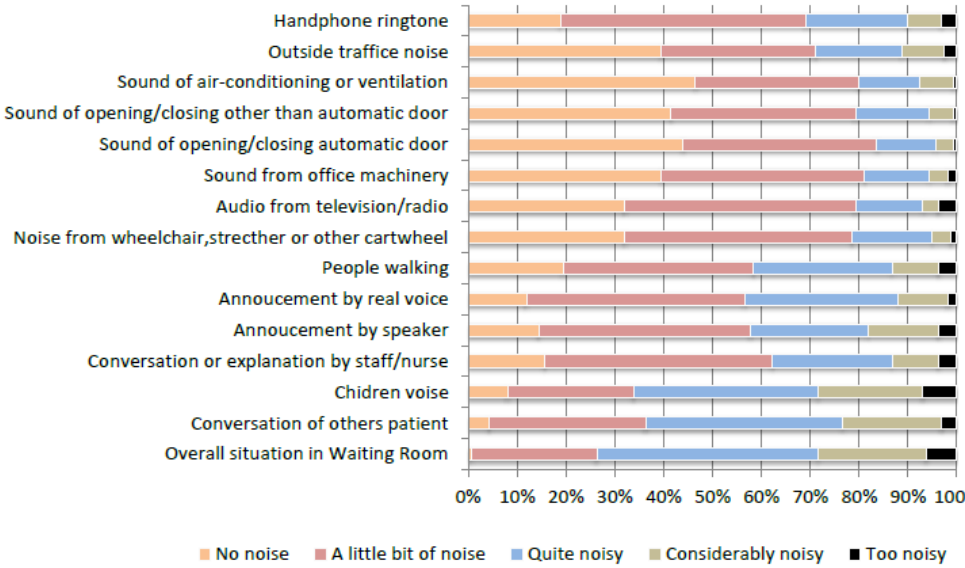


(a) Hospital A

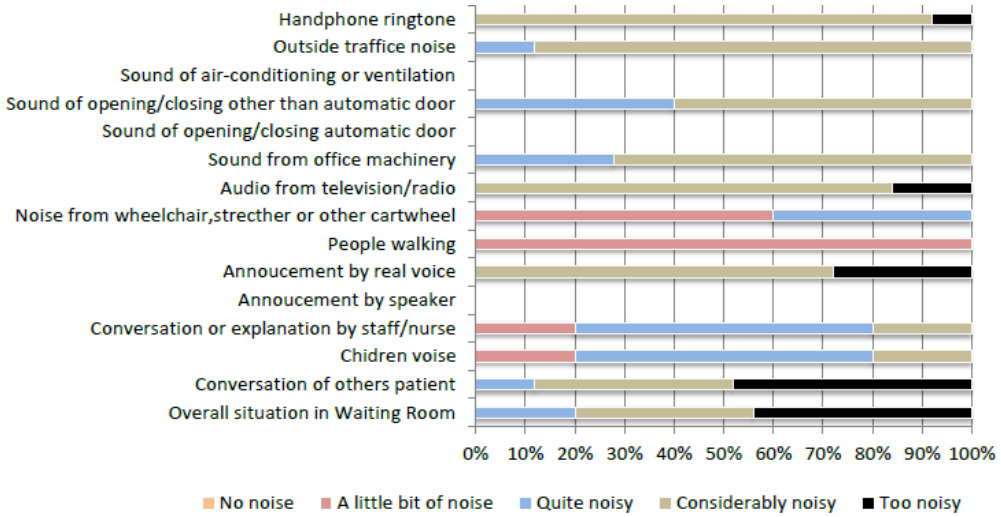


(b) Hospital B

Figure 6. Level of satisfaction for the survey's subject in both hospitals

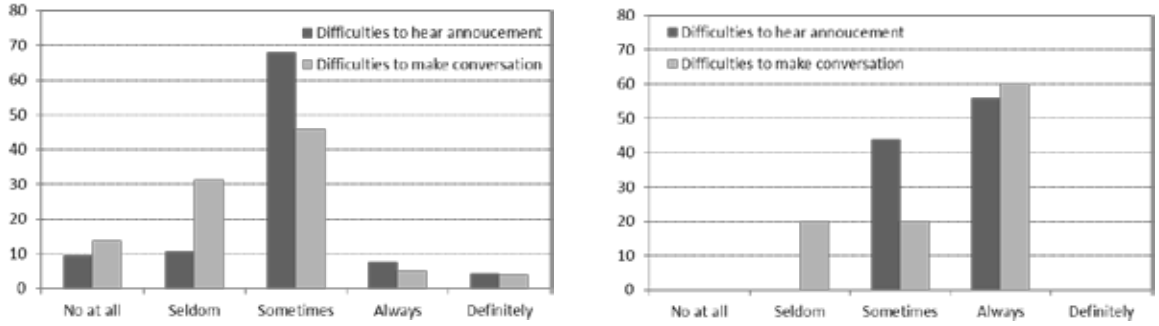


(a) Hospital A



(b) Hospital B

Figure 7. Noise level on the selected subjects in both hospitals



(a) Hospital A (b) Hospital B

Figure 8. The level of difficulties to hear announcement and to make conversation

4. Conclusions

The fundamental stage of this study, both in physical and in psychological surveys of acoustical environment in hospital waiting areas have been presented. Noise levels of waiting area were found to be worse than recommended ones. Based on the results from questionnaire surveys, it was clearly found the existing noise sources during respondent's waiting time reflected to the total evaluation of the acoustic environment in both hospitals. The survey results in both waiting areas in two hospitals also support the measurement results: it can be said that many of the noise are mainly generated by people in the waiting area. Further investigations on acoustical characteristics of waiting areas itself will be required and now being pursued intensively.

REFERENCES

[1] Baker C. Sensory overload and noise in the ICU: Sources of environmental stress, *Critical Care Nursing Quarterly*, **6**, 66-79 (1984).

[2] Topf M. Noise-induced occupational stress and health in critical care nurses, *Hospital Topics*, **66**, 30-34 (1988).

[3] Busch-Vishniac I.J., West J.E., Barnhill C., Hunter T., Orellana D. and Chivukala R. Noise levels in John Hopkins Hospital, *Journal of Acoustical Society of America*, **118**(6), (2005).

[4] Evans J.B. and Philbin M.K. The acoustic environment of hospital nurseries: Facility and operations planning for quiet hospital nurseries, *Journal of Perinatology*, **20**, (2000).

[5] Toyomasu M., Otsuru T., Tomiku R., Okamoto N. and Uchinoura Y. Acoustic environments in outpatient department in hospitals, *The 8th International Congress on Sound and Vibration*, Hong Kong, China, (2001).

[6] Huet E., Jakmakjian G., Bussieres J.-F. and Leroux T. A pilot study of noise level in a pharmacy department in a teaching hospital, *10th International Congress on Noise as a Public Health Problem (ICBEN)*, London, UK, (2004)

[7] Tsiou C., Efthymiatos G. and Katostaras T. Noise in the operating rooms of Greek hospitals, *Journal of Acoustical Society of America*, **123**(2), (2008).

[8] Planning guidelines for environmental noise limits and control, *Department of the Environment, Malaysia*, (2004)

[9] Guidelines for Community Noise, *World Health Organization*. (1999).