Vocal problems among nurses working in the intensive care unit during the COVID-19 pandemic in China

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ABSTRACT

This study explored the effects of noise on medical staff in intensive care units (ICUs) in China during the COVID-19 pandemic. Firstly, noise levels were measured for 24 hours measured in four ICUs and noise sources were identified. Secondly, online questionnaire surveys were conducted to analyse the self-rated vocal perception of the ICU nurses who wore face masks. Participants were recruited from four ICUs and a total of 100 nurses from each ICU took part in the surveys. Lastly, the voice-related parameters were measured by using a monitor in four ICUs. For this, a non-invasive accelerometer was attached to a participant's neck during working hours. The noise levels in the ICUs exceeded the WHO recommended values. The most frequent voice symptom was the 'dryness in the throat' and followed by the 'difficulty in being heard' 'The voice levels of the nurses were not much influenced by the background noise levels.

1. INTRODUCTION

It is well known that patients in the intensive care units (ICUs), who undergo complex critical care treatment, are exposed to high sound pressure levels [1]. In addition to monitoring alarm noise, nurses' activities and consultants contribute to noise burden [2, 3]. The World Health Organization (WHO) recommends the noise level in hospitals for daytime (7:00-23:00) and night time (23:00-07:00). During the daytime, the recommended values for wardrooms are 35 dBA (L_{Aeq}), while the values for the night is 40 dBA (L_{Amax}) [4].

Importantly, many tasks performed by nurses require high levels of concentration, and an average sound pressure level (LAeq) of 40 dB (A) may lead to disruption of activities that require concentration and induce a higher probability of error (Konkani and Oakley, 2012). [5]. Most studies have focused on the non-auditory health effects such as sleep disruption and alarm fatigue [6, 7]. However, there has been little attempt to investigate the influences of noise on the vocal health of the medical staff. Many studies have reported occupational risks for voice problems. For example, Verdolini and Ramig [8] demonstrated that teachers were the most at-risk occupation for a voice problem but healthcare workers also showed the second largest risk

of voice problem. Therefore, it is necessary to explore the effects of noise on voice problems of staff in the ICUs.

The present study aims to examine the vocal problems among nurses working in the ICUs in China, especial during the recent COVID-19 pandemic. Field measurements were performed in four ICUs to see the noise levels and sources. Also, questionnaire surveys and voice monitoring were carried out to see the impacts of noise on perceived and measured voice problems.

2. METHODOLOGY

2.1 Sites

This study was conducted in four ICUs (sites A, B, C and D) in China from December 2020 to April 2021. Site A is the smallest and was recently rebuilt from the old factory. Site B is the largest and Site D is a part of the local university in Chongqing, China. Noise levels measured for 24 hours are listed in Table 1. The noise levels exceeded the WHO recommended values. In particular, the noise level in the 10-bed ward was greater than 60 dB in Site D.

Table 1: Noise levels for 24 hours in ICUs (L_{Aeq}, dBA). Numbers in parentheses represent standard deviation

	Site A	Site B	Site C	Site D
Nurse station	55.13 (5.24)	58.79 (4.21)	58.60 (3.8)	59.20 (5.56)
1 bed-ward	N/A	54.09 (4.14)	N/A	51.07 (6.16)
2-bed-ward	N/A	56.51 (4.21)	N/A	N/A
6-bed ward	54.55 (3.43)	56.65 (3.82)	N/A	N/A
10-bed ward	N/A	N/A	57.45 (3.97)	60.28 (4.38)

2.2 Participants

A total of 100 participants (20 from Site A, 40 from Site B, 20 from Site C, and 20 from Site D) were recruited from four hospitals. Table 2 shows the sociodemographic and professional characteristics of the participants. The participants aged between 25-38 (mean 34.6, SD 3.21) with the same educational level. Seventy-one nurses have worked in the ICUs for between five to ten years and twenty-two participants have worked for more than 10 years. During working hours, all the participants wore two different face masks with STI (speech transmission index) of 0.84 at 2 meters away from the Head and Torso Simulator (Type 4128C, B&K).

Table 2: Characteristics of nurses

	Site A	Site B	Site C	Site D	Total
Gender					
Male	0	1	2	0	3
Female	20	39	18	20	97
Age (yrs.)					
20-25	0	0	0	0	0
25-30	5	13	3	3	24
30-35	13	19	16	17	65
>35	2	8	1	0	11
Role					
Nurse manager	1	1	1	1	4
Clinical nurse specialist	3	7	2	2	14

Charge nurse	2	3	2	1	8
Nurse	14	29	15	16	74
Years of working in ICUs					
<1	0	0	0	0	0
1-2	0	0	0	0	0
2-5	3	1	2	1	7
5-10	14	28	12	17	71
>10	3	11	6	2	22

2.3 Questionnaire survey

the participants completed online questionnaire surveys after voice monitoring. The questionnaire consisted of three main parts: 1) basic information such as age and gender, 2) vocal problems in ICUs and 3) perception of the acoustic environment. The participants were asked to rate the experience of the vocal symptoms using a 5-point scale (‘1’: never happened and ‘5’: always happen). The Voice Handicap Index (VHI-30) was also used to measure the self-perception of voice handicap. In addition, the participants were asked about noise sources and they rated perception of acoustic environments using a semantic scale.

2.4 Voice monitoring

The voice monitoring was carried out for 4 hours during working hours using the Voice-Care device (PR.O. VOICE S.r.l, Turin, Italy). The Voice-Care device provides information on the fundamental frequency (Hz), phonation time percentage (Dt%), and vocal sound pressure level (dB SPL). Phonation time percentage is defined as the percentage of time spent phonating over the total recording time. Before the monitoring, the device calibrated in a quiet room in each hospital using a reference microphone.

RESULTS

Questionnaire survey

Table 3 shows the frequency and types of voice symptoms reported by nurses across four ICUs. It was assumed that the participant experienced voice symptoms if they selected ‘3’, ‘4’ and ‘5’ on a 5-point scale. ‘Dryness in the throat’ was the most frequently experienced symptom, followed by ‘difficulty in being heard’ and ‘clearing the throat’. In particular, 65% of the nurses in Site D experienced ‘dryness in the throat’. Among four sites, the nurses from Site B showed more frequent symptoms compare to other sites.

Table 3: Frequency and types of voice symptoms (%)

Symptoms	**Site A**	**Site B**	**Site C**	**Site D**	**Total**
Dryness in the throat	5	55	5	65	37
Difficulty in being heard	15	45	15	45	33
Clearing the throat	20	40	20	35	31
Voice tiredness	10	42.5	15	30	28
Lump in the throat	10	37.5	10	20	23
Sore throat when speaking	0	37.5	10	25	22
Hoarseness	15	27.5	20	5	19

Persistent dry cough	0	37.5	0	0	15
Voiceless	0	15	20	10	12
Aphonia	5	15	10	5	10

Results of VHI-30 are listed in Table 4. The median values of the total VHI-30 score were less than 30 for all the sites, indicating that the handicap associated with the voice disorder is minimal. However, the number of nurses whose total VHI-30 score is greater than 30 were 24. This means that 24% of the participants might have a voice disorder.

Table 4: Median scores for the total VHI-30 and VHI subscales

VHI	Site A	Site B	Site C	Site D	Total
Total VHI-30	20	29	20	22.5	23
Functional subscale	6.5	10	8	8	8
Emotional subscale	6	8	7	7.5	7
Physical subscale	6.5	9.5	6.5	6	7.5

Voice monitoring

Results of voice monitoring are listed in Table 5. Mean values of the vocal sound pressure levels were similar across the nurses from four sites. The nurses who worked in Site D showed the lowest mean value of the vocal sound pressure level, while the nurses from Site B had the greatest mean value. The nurses from Site B showed significantly greater mean values of the fundamental frequency (f0) than those of Sites A, C and D. Similarly, the nurses from Site B showed the lowest mean value of Dt.

Table 5: Voice-related parameters averaged across the participants. Numbers in parentheses represent standard error. F0 and Dt represent fundamental frequency and phonation time percentage, respectively.

Voice Parameters	Site A	Site B	Site C	Site D
SPL mean (dB)	74.5 (1.3)	77.6 (4.34)	76.7(2.7)	74.3 (1.0)
SPL, standard deviation (dB)	2.24 (1.7)	3.88 (2.7)	3.43 (2.3)	2.64 (1.4)
F0, mean (Hz)	245.9 (6)	380 (11)	276.4 (10)	266.3 (8)
F0, standard deviation (Hz)	60.2 (3)	62.7 (6)	61.3 (4)	57.6 (3)
Dt [%]	7.17 (2)	11.6 (4)	9.3 (4)	6.2 (3)

As shown in Figure 1, the correlation between the background noise levels and voice SPLs across the working hours was low (r=0.273, p=0.001). The correlation coefficients for individual nurses varied from 0.019 to 0.279. The voice SPL showed a much smaller ranger than that of the background noise level in the ICUs.

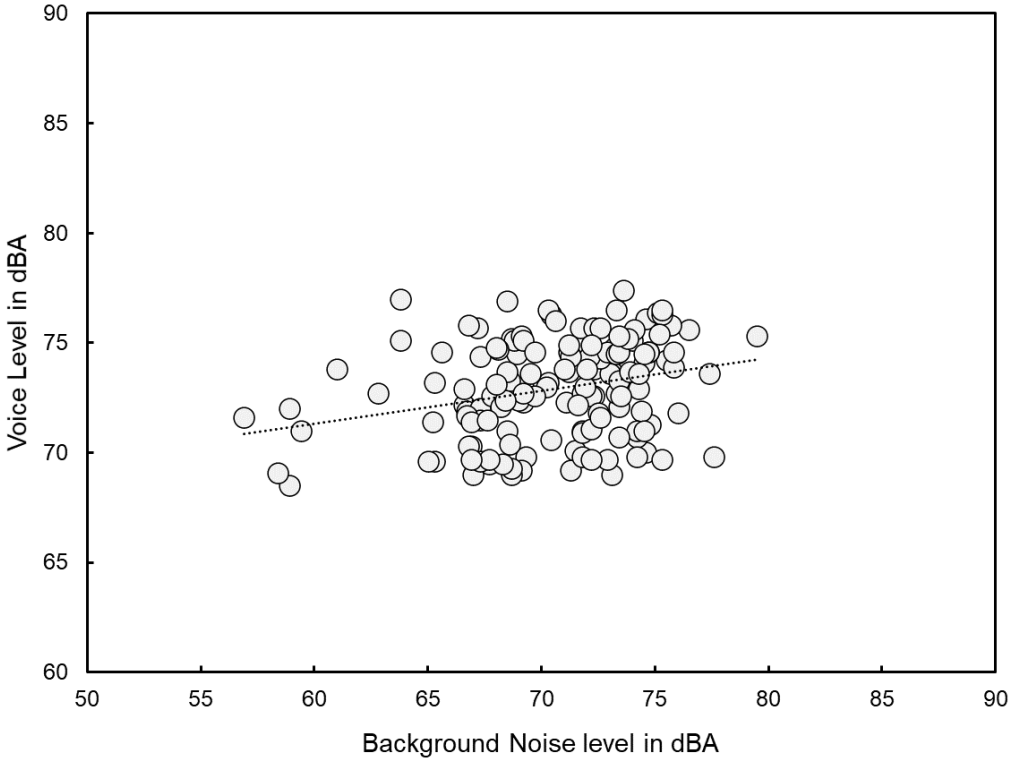

Figure 1: Relationships between voice levels and background noise levels in the ICUs. Dashed lines depict the regression line.

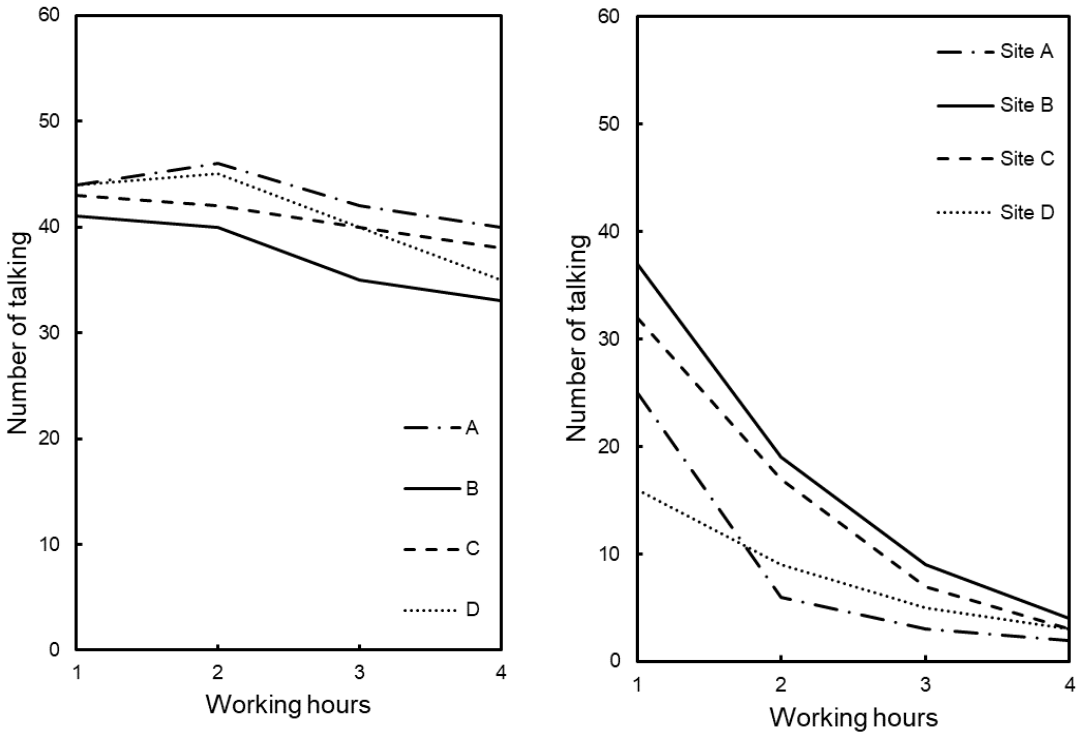

Figure 2: Number of talking across working hours in daytime (left) and night time (right).

Figure 2 shows the numbers of talking analysed for dayshift (08:00-12:00) and nightshift (21:00-01:00). The nurses from Site B showed the lowest and highest numbers in daytime and night time, respectively. The numbers of talking gradually decreased with working hours in the daytime, whereas those in the night time sharply decreased. Repeated measures analysis of variance (ANOVA) confirmed that the effect of working hours on the number of talking was significant ($F(9,108) = 15.026, \mathrm{p} = 0.025$). The significant difference was also found in the night time ($F(9,108) = 36.981, \mathrm{p} < 0.001$).

SUMMARY

The present study explored the effects of noise in the ICUs on the voice problems of the nurses. Noise measurements revealed that the noise levels in four ICUs in China exceeded the WHO recommended values. The result of the questionnaire survey indicated that dryness in the throat' was the most frequently experienced symptom. The median value of the total VHI-30 score indicated that the voice handicap associated with voice disorder would be minimal. It was found that the mean values of voice SPLs were not much affected by the background noise levels.

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