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Correlation between subjective and objective voice analysis pre- and post-shift among teleoperators in a tertiary hospital

M Rahman, J Saniasiaya and M Z Abu Bakar

Department of Otorhinolaryngology, Faculty of Medicine, Universiti Malaya, Kuala Lumpur, Malaysia

Main Article

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Author for correspondence:
Dr J Saniasiaya, Department of Otorhinolaryngology, Faculty of Medicine, Universiti Malaya, Kuala Lumpur 50603, Malaysia
E-mail: shakthy_18@yahoo.com

Abstract

Objective. Teachers and singers have been extensively studied and are shown to have a greater tendency to voice disorders. This study aimed to investigate the correlation between subjective and objective voice analysis pre- and post-shift among teleoperators in a tertiary hospital.
Methods. This was a prospective cohort study. Each patient underwent pre- and post-shift voice analysis.
Results. Among 42 teleoperators, 28 patients (66.7 per cent) completed all the tests. Female predominance (62 per cent) was noted, with a mean age of 40 years. Voice changes during working were reported by 48.1 per cent. Pre- and post-shift maximum phonation time ($p < 0.018$) and Voice Handicap Index-10 ($p < 0.011$) showed significant results with no correlation noted between subjective and objective assessment.
Conclusion. Maximum phonation time and Voice Handicap Index-10 are good voice assessment tools. The quality of evidence is inadequate to recommend 'gold standard' voice assessment until a better-quality study has been completed.

Introduction

Voice plays a significant role in communication. It is also a notable source of income in specific work or professions. This group of workers, termed 'occupational voice users', includes teachers, singers, telemarketers and broadcasters, who rely on their voices to perform their occupational duties.[1]

It is noteworthy that voice disorders have been found to be prevalent among various occupation-related voice users. The career prevalence of voice problems in call centre operators varies between 33 and 68 per cent.[2] Yet there is an urgent need for research to support occupational voice health and safety risk measurement, prevention and intervention. A meta-analysis published by Cutiva *et al.* found a total of 18 cross-sectional studies.[3] The authors demonstrated that most of the included studies carried out voice assessments based on questionnaires and found that the prevalence of voice disorders among occupational voice users ranged from 11 to 18 per cent. Moreover, occupational voice users showed up to four times more likelihood of having a voice disorder than non-occupational voice users.[3]

Teachers and singers have been extensively studied and reported to have higher frequencies of voice disorders than the general population compared with telemarketing operators. Nevertheless, the lack of 'gold standard' voice assessment results in varying results across the available data. This study investigated subjective and objective voice assessment among teleoperators in a tertiary hospital pre- and post-shift.

Materials and methods

Study design

This was a prospective cross-sectional study. This study was approved by the University of Malaya Medical Centre ethics committee (number: 202156-10113) in compliance with the ethical standards of the Declaration of Helsinki. All participants reviewed and signed the free and informed consent form.

Patients

The study involved teleoperators working in a single tertiary centre. A total of 42 teleoperators were invited for voice assessment pre- and post-working shift. Each teleoperator underwent subjective voice assessment, including a voice disorders questionnaire, Voice Handicap Index-10, Grade, Roughness, Breathiness, Asthenia, Strain scale and maximum phonation time. The data collection was carried out pre-shift and post-shift, and the assessment was carried out in a quiet room (noise level under 50 dB).[4]

Subjective voice assessment

Two questionnaires were used for this study: the voice disorders questionnaire and Voice Handicap Index-10. The voice disorder questionnaires were extracted from a 'voice survey' questionnaire developed by Amorim *et al.*[4] The Malay version of Voice Handicap Index-10 was the other questionnaire utilised to assess voice.[5] Voice Handicap Index-10 was adapted from the original Voice Handicap Index to provide a quick, reliable and quantifiable measure of patients' own vocal handicap perception.[5]

For both maximum phonation time and Grade, Roughness, Breathiness, Asthenia, Strain scales, the emission of the sustained vowel ɛ:/ was chosen because it allows the stabilisation of the vocal tract in a neutral and medial position. It is known that the maximum phonation time value for an adult male is between 25 and 35 seconds, and for an adult female it is about 15–25 seconds. The Grade, Roughness, Breathiness, Asthenia, Strain scale was used for voice quality description. The voice quality was scored from 0 to 3 (0: normal, without any alteration; 1: mild voice deviation; 2: moderate voice deviation; 3: severe voice deviation).

Objective voice assessment

For objective voice assessment or acoustic voice analysis, validated Praat speech analysis software was used. Praat software is favoured as it is free software, readily available and user-friendly, and constantly updated by the developer.[6] Following procedure explanation, a vocal sample encompassing sustained vowel emissions (/ɛ/ three consecutive times at comfortable pitch and loudness) was recorded. The samples were recorded onto a unidirectional headset microphone (Plantronics audio 40, California, USA), placed approximately 10 cm from the lips of each patient.[4] Voice recording was initially carried out using Praat software, and three parameters, (voice frequency, jitter and shimmer) were assessed. The mean frequency for adult males was 128 Hz, and for adult females it was 225 Hz. For jitter, the normal percentage was less than or equal to 1.040 per cent, whereas for shimmer percentage it was less than or equal to 3.810 per cent.

Statistical analysis

Data were cleaned, explored and analysed using SPSS® statistical software (version 28.0). Descriptive statistics were used to present the characteristics of the patients. The distribution of the continuous data was explored using a histogram and presented as mean ± standard deviation (SD) because they were found to be normally distributed. Categorical variables were presented as frequency and percentage.

Between-group differences in the outcomes were explored using the independent sample *t*-test, and the correlation between two continuous variables was explored using the Pearson correlation test. All the tests were two-sided, and statistical significance was denoted as $p < 0.05$.

Results

Demography

Of the 42 teleoperators, 28 patients completed pre- and post-shift voice assessments and were involved in this study. Female predominance (62 per cent) was noted, with a mean age of 40 years (range: 26–58 years). Working experience among the patients varied between 1 and 29 years, with a mean of 11 years. The majority (92.6 per cent) of the patients had never undergone formal speech training before beginning their shift. Hence, no vocal warm-up was performed routinely before working.

Among the patients, 48.1 per cent reported voice changes during working, although the precise timing of voice changes during the shift was not assessed. The most common voice symptom was constant throat clearing (56.1 per cent), followed by hoarseness (37.5 per cent), sore throat (31.3 per cent), fatigue when speaking and foreign body sensation (18.8 per cent), constant cough and aphonia (12.5 per cent), and weak voice (6.3 per cent) (Figure 1).

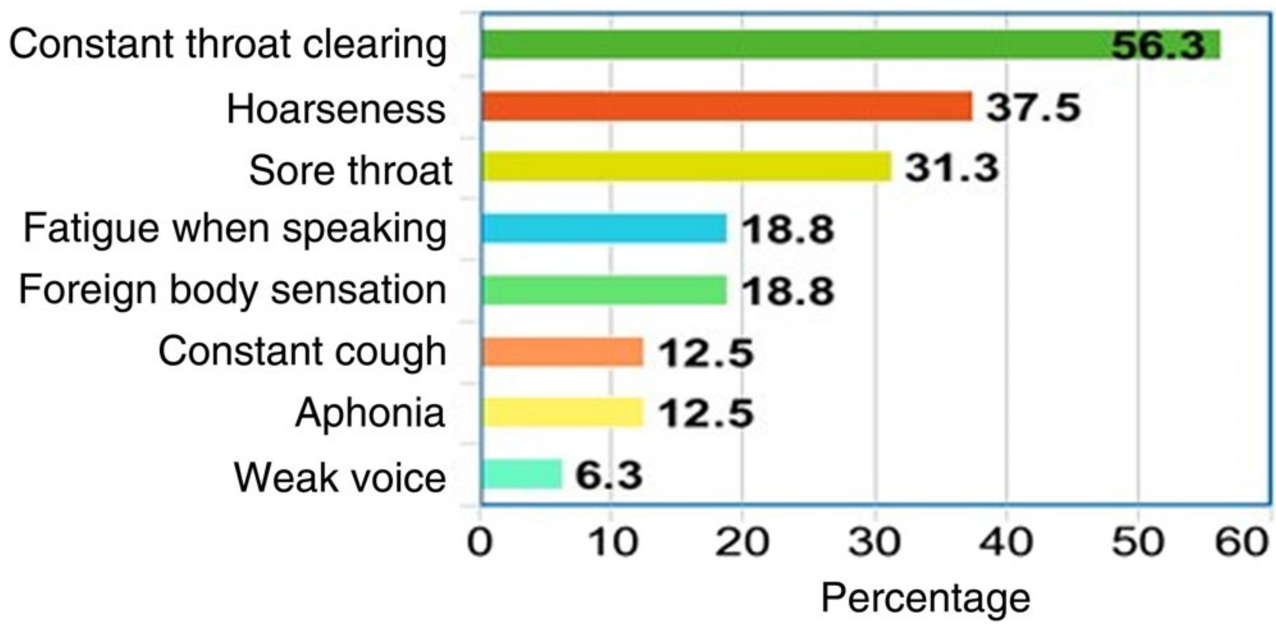

Fig. 1. Reported voice symptoms.

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Table 1. Significant difference between pre- and post-shift for maximum phonation time

Parameter	Time (mean (SD); seconds)	Mean difference (95% CI)	*P*-value
Pre-shift	16.55 (6.91)	1.37 (0.249, 2.490)	0.018
Post-shift	15.18 (6.53)		

SD = standard deviation; CI = confidence interval

Table 3. Significant difference pre- and post-shift for Voice Handicap Index-10 score

Parameter	Score (mean (SD))	Mean difference (95% CI)	*P*-value
Pre-shift	5.38 (3.98)	1.34 (0.327, 2.363)	0.011
Post-shift	4.03 (3.30)		

SD = standard deviation; CI = confidence interval

Maximum phonation time

The mean maximum phonation time pre-shift was 16.55 seconds, with a highest maximum phonation time pre-shift of 34 seconds and a lowest maximum phonation time post-shift of 15.1 seconds. A statistically significant reduction of maximum phonation time was demonstrated (correlation co-efficient: 1.37, $p < 0.018$) (Table 1).

Grade, Roughness, Breathiness, Asthenia, Strain scoring

No statistical significance was demonstrable from pre- to post-shift when using Grade, Roughness, Breathiness, Asthenia, Strain scoring among our patients (Table 2).

Voice Handicap Index-10

Voice Handicap Index-10 showed a statistically significant difference pre- and post-shift among our patients ($p < 0.011$), although most teleoperators scored less than 10, which suggests either normal or mild vocal symptoms (Table 3).

Acoustic voice analysis using Praat software

No statistical significance was noted between pre- and post-shift acoustic analysis measurements for frequency, jitter and shimmer (Table 4). This study showed no correlation between pre- and post-subjective and objective voice assessment between teleoperators.

Discussion

Our study found that the prevalence of voice disorders among teleoperators in our centre was 48.1 per cent, predominantly affecting female workers (84.6 per cent) with a mean working experience of 11 years. The findings in our study are parallel to the systematic review by Nair *et al.*, which reported a prevalence of between 33 and 68 per cent of voice disorders among call centre operators.[2] Similarly, a high prevalence rate of approximately 70 per cent was reported among telemarketers by several other studies.[7,8] The work burden of teleoperators working in a hospital may be reckoned to be lower compared with telemarketers. However, our data show that the impact on the voice pre- and post-shift is similar. In contrast, Cutiva *et al.* reported that the prevalence of voice disorders among occupational voice users was less than 11 per cent when shorter recall period studies were included.[3] The assessment method demonstrated a significant contribution to the prevalence rates: studies based on clinical examinations such as stroboscopy and video laryngoscopy showed higher prevalence rates of voice disorders compared with studies using questionnaires to assess voice disorders.[3]

- Work-related voice disorders involve not only teachers and singers but also teleoperators and telemarketers
- The high prevalence of voice disorders among teleoperators results from high vocal demand
- Subjective voice assessment, notably maximum phonation time and Voice Handicap Index, provides good information and data to diagnose voice disorders
- Objective voice assessment (acoustic analysis) can be an adjunct to diagnosing voice disorder
- Voice training by speech therapists is needed for all occupational voice users as a part of training

We found that the subjective voice analysis using maximum phonation time and Voice Handicap Index-10 showed significant differences pre- and post-shift among teleoperators (maximum phonation time ($p < 0.018$) and Voice Handicap Index ($p < 0.011$)). Schindler *et al.*, in a study of patients with functional and structural dysphonia, found that Voice Handicap Index is comparable with maximum phonation time; correlation was noted between maximum phonation time and the functional and physical domain of Voice Handicap Index ($r = 0.583$ and $r = 0.683$, respectively).[9] Grade, Roughness, Breathiness, Asthenia, Strain scoring showed no statistically significant changes in our study; this was also reported by Girardi *et al.* in a study in which a severe degree of alteration in voice parameters was not demonstrable among patients

Table 2. Distribution of the GRBAS score pre- and post-shift

Parameter			Post-GRBAS			
			Normal	Mild	Moderate	Severe
Pre-GRBAS	Normal	Participants (*n*)	16	3	1	0
		% within post-GRBAS (%)	100.0	33.3	50.0	0.0
	Mild	Participants (*n*)	0	6	1	1
		% within post-GRBAS (%)	0.0	66.7	50.0	50.0
	Moderate	Participants (*n*)	0	0	0	1
		% within post-GRBAS (%)	0.0	0.0	0.0	50.0

Most of the patients had normal Grade, Roughness, Breathiness, Asthenia, Strain (GRBAS) score

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Table 4. Significant difference between pre- and post-shift for frequency, jitter and shimmer

Parameter	Mean (SD)	Mean difference (95% CI)	*P*-value
Frequency (Hz)			
– Pre-shift	155.01 (43.73)	(−27.943, 7.820)	0.259
– Post-shift	165.07 (53.06)		
Jitter (%)			
– Pre-shift	0.61 (0.50)	(−0.039, 0.314)	0.122
– Post-shift	0.47 (0.18)		
Shimmer (%)			
– Pre-shift	7.16 (4.22)	(−0.470, 2.536)	0.170
– Post-shift	6.13 (3.24)		

SD = standard deviation; CI = confidence interval

using Grade, Roughness, Breathiness, Asthenia, Strain and Instability scale.[10]

Although the pre- and post-shift objective voice analysis using Praat software showed changes pre- and post-shift, these were not statistically significant (frequency ($p = 0.259$), jitter ($p = 0.122$) and shimmer ($p = 0.17$)). This could be attributed to the small sample size of our study. Akin to that, Amorim *et al.* found no difference in acoustic analysis data ($p = 0.738$) when comparing pre- and post-shift voice among their patients. Nonetheless, emerging non-standardised acoustic analysis programmes could contribute to addressing the inconclusive outcome and varying data. Moreover, differences in the algorithms hinder the normalisation of objective voice measures (Tables 5 and 6).[4]

To date, the 'gold standard' voice assessment tool is still unknown. When comparing subjective and objective acoustic analysis, most studies showed varying results. No significant

Table 5. Correlation between pre-shift measurements

Parameter	Frequency	Jitter	Shimmer	MPT	VHI
Frequency					
– Pearson correlation, *r*	1	−0.08	0.43	−0.01	0.10
– *P*-value		0.70	0.019	0.528	0.609
Jitter					
– Pearson correlation, *r*		1	0.20	−0.34	0.002
– *P*-value			0.290	0.071	0.99
Shimmer					
– Pearson correlation, *r*			1	−0.25	−0.26
– *P*-value				0.201	0.181
MPT					
– Pearson correlation, *r*				1	−0.24
– *P*-value					0.210
VHI					
– Pearson correlation, *r*					1
– *P*-value					

There was no correlation between pre-shift measurements. MPT = maximum phonation time; VHI = Voice Handicap Index

Table 6. Correlation between post-shift measurements

Parameter	Frequency	Jitter	Shimmer	MPT	VHI
Frequency					
– Pearson correlation, *r*	1	−0.17	0.12	0.02	−0.15
– *P*-value		0.376	0.546	0.923	0.438
Jitter					
– Pearson correlation, *r*		1	0.61	−0.32	0.06
– *P*-value			<0.001	0.092	0.763
Shimmer					
– Pearson correlation, *r*			1	−0.11	0.09
– *P*-value				0.559	0.628
MPT					
– Pearson correlation, *r*				1	−0.17
– *P*-value					0.367
VHI					
– Pearson correlation, *r*					1
– *P*-value					

There was no correlation between post-shift measurements. MPT = maximum phonation time; VHI = Voice Handicap Index correlation could be demonstrated between Voice Handicap Index and specific acoustic measures in any consistent manner.[11,12] Woisard *et al.* demonstrated that there was no significant correlation between the different scores (total and subscales) and the acoustic parameters (harmonics-to-noise ratio, jitter and shimmer), the aerodynamic parameters (maximum phonation time, mean flow and subglottal pressure) and the Dysphonia Severity Index.[12] In our study, we found no correlation between acoustic analysis (frequency, jitter and shimmer) and subjective analysis using maximum phonation time and Voice Handicap Index-10 pre- and post-shift, most likely because of the small sample size. On the other hand, Niebudek-Bogusz *et al.* reported that acoustic parameters among their patients significantly correlated with the functional and emotional subscales of the Voice Handicap Index.[13]

Professionals who rely on voice should have formal speech-language training and advice for voice intervention as a part of training. Speech therapists need to identify vocal characteristics that are common to this group.[14] In our study, 92.6 per cent of our patients had never undergone formal speech training, resulting in no daily vocal warm-up prior to commencement of their shift. This could have contributed to the voice complaints amongst our patients. Voice training should be advocated as a part of teleoperators' training before job commencement. In addition to that, regular intake of water, proper air humidity and avoidance of risk factors that could result in dryness of the vocal fold mucosa need to be highlighted to all occupational voice users.[14–17]

Conclusion

The incidence of voice disorders among teleoperators in our centre is 48.1 per cent. Pre- and post-shift voice assessment shows significant changes, for which we found maximum phonation time and Voice Handicap Index-10 to be good voice assessment tools. The quality of evidence is inadequate to recommend 'gold standard' voice assessment until a better-quality study has been completed, and future randomised, controlled studies with a large sample size are warranted.

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Competing interests. None declared

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