USE OF THE PROGRAM MDVP IN DIFFERENT CONTEXTS: A LITERATURE REVIEW

Uso do programa mdvp em diferentes contextos: revisão de literatura

Mara Keli Christmann[1], Ana Rita Brancalioni[2], Carolina Ramos de Freitas[1], Diéssica Zacarias Vargas[1], Márcia Keske-Soares[1], Carolina Lisbôa Mezzomo[1], Helena Bolli Mota[1]

ABSTRACT

The purpose of this study is to describe, from literature review, acoustic analysis using *Multi Dimensional Voice Program*, reliability of their measurements and their comparison with other acoustic analysis programs; characterization of voices of different groups, and its use to assess the effects and effectiveness of different therapeutic procedures. Conducted literature that prioritized the past five years, including articles whose purpose was according to the interest of this review. The survey was conducted in the databases of Lilacs, BIREME, PubMed, Medline, SciELO and Google Scholar, using the descriptors acoustic, speech acoustics and voice. The most commonly used measures are fundamental frequency, jitter, shimmer and harmonic-noise ratio. The measures of tremor not have as much reliability. The most consistent measures that present a high correlation with other acoustic analysis programs are related to fundamental frequency. Several studies aim to characterize different types of voices such as those of subjects without vocal of both sexes, in order to establish normality parameter for different population groups. In addition, some studies were characterized with different voices disorders. Acoustic analysis is a resource objective and necessary in the evaluation of patients with voice disorders and especially the comparison of several uncles treatment.

KEYWORDS: Voice; Speech Acoustics; Voice Quality; Speech Recognition Software; Acoustics

INTRODUCTION

The human ear is prepared to perceive voice as a whole, which is advantageous from the point of view of linguistic communication. But such ability becomes limited when it is decisive for the individualization of relevant clinical aspects. For this reason, it is difficult to determine the origin of certain voice disorders when using only subjective tools such as the auditory-perceptual assessment[1-3].

Accordingly, the number of researches in speech therapy has increased, which use techniques and tools that provide objective and increasingly reliable results. The Multi Dimensional Voice Program (MDVP) is a standard software for acoustic assessment which is widely used by many researchers in the voice field for being very comprehensive. Thus, it is important to study its particularities.

Acoustic vocal assessment consists of a noninvasive process of obtaining objective measures from signal. Because of its exceptional accuracy, it allows evaluators to recognize voice alterations early and helps compare the effects and efficiency of several vocal techniques or other voice therapeutic procedures, even if they produce subtle changes[4-6].

Among the advantages of using this method in voice assessment is the fact that it is noninvasive and deliver numerical parameters. One of the major current limitations is that is has not been possible yet to establish an exact correlation between the numerical parameters of the acoustic analysis with the auditory-perceptual aspects of voice [1,2].

Given the above, this study is the result of a literature review aiming to describe the reliability of acoustic analysis using the Multi Dimensional Voice Program, compare its measures with other acoustic

(1) Universidade Federal de Santa Maria/UFSM, Santa Maria, RS, Brasil.

(2) Universidade de Passo Fundo/UPF, Passo Fundo, RS, Brasil.

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analysis software, characterize voices from different groups, and use it to verify the effects and effectiveness of different therapeutic procedures.

METHODS

A theoretical and exploratory survey was conducted using the non-systematic method of literature review. Only original research articles and those based on bibliographic review on MPVP from traditional and modern national and international sources of literature were included. The search was carried out on Lilacs (Latin-American and Caribbean Center on Health Sciences Information), Bireme (Regional Library of Medicine), Medline (Medical Literature Analysis and Retrieval System on Line), PubMed (Medical Publications), Scielo (Scientific Electronic Library Online), and Google Scholar databases. The Health Science Descriptors (DeCS, 2013) used to find the papers were: *acoustic, speech acoustics* and *voice*. The search was made using isolate descriptors and later by combining them.

In total, 102 articles were retrieved, and of this 15 were excluded at once for being studies involving the use of medications. So, 87 articles were first selected before reading the abstracts. Of these, it was included in the present survey all papers published in between 2008 to 2013, having any of the following approaches: reliability of MDVP; comparison between MDVP and other acoustic analysis tools; use of acoustic assessment to compare vocal techniques used in speech therapy.

The criteria used for exclusion were: periodicals not indexed in the above databases; articles whose data of publication exceeded five years, except two papers of 2002 and 2007 which were included by the authors for being considered relevant to the present review. In addition, articles addressing comparative acoustic measures before and after treatment of non-vocal pathologies were also excluded.

Based on the above criteria, 37 papers were selected for analysis. First, these articles were organized according to the authors, title, publication year, and kind of study. Based on this categorization, the references were grouped according to the themes that gave origin to the subtitles of the present work, namely: “Acoustic analysis using MDVP: reliability of the software and measures”; “Comparison with other acoustic assessment programs”; “Characterization of voices of different groups”; “Use of the MDVP system to verify the effect and effectiveness of different therapeutic procedures”.

LITERATURE REVIEW

Acoustic analysis using MDVP: reliability of the software and measures

The MDVP software of Kay Pentax® calculates 33 measures, and those of major interest in the literature are the frequency measures: f0; maximum f0 (fhi); minimum f0 (flo); standard deviation f0 (STD); frequency perturbation measures; absolute jitter (*Jita*); *Jitter* percentage (*Jitt*); Relative measure of the *pitch* disturbance (RAP); *pitch* perturbation quotient (PPQ); smoothed pitch perturbation quotient (sPPQ); f0 variation (vf0); measures of perturbation intensity: *Shimmer* in dB (ShdB); percentage *Shimmer* (Shim); amplitude perturbation quotient (APQ); smoothed amplitude perturbation quotient (sAPQ); amplitude variation (vAm); Noise-to-harmonics Ratio (NHR); Voice turbulence index (VTI); Smoothed phonation index (SPI); voice break measures: Degree of voice breaks (DVB); Number of voice breaks (NVB); mute or unvoiced segments measures: Number of unvoiced segments (NUV); Degree of unvoiced segments (DUV); sub-harmonic segments measures: Degree of sub-harmonics (DSH); Number of sub-harmonics (NSH)[1,4,7,8].

There are a great number of studies in the literature using the MDVP software as an assessment tool for acoustic analysis. Firstly, it is possible to locate studies that evaluate the reliability of the program and its measures. The f0, jitter, shimmer and NHR measures are widely used by researchers [9-12]. Such objective parameters are important for the assessment of patients with voice disorders.

In addition, measures of tremor such as FATr and FFTr are also often analyzed by many studies[13,14]. However, such measures may show variations according to the time of emission or the analyzed text. A study aiming to reduce the effects of such measure fluctuations used constant voiced speech time of 3,000 ms as starting points and performed averages of seven consecutive measures involving FATr and FFTr[13].

Another study[15] investigated tremor measurements comparing 25 voices of subjects with Parkinson’s disease with 24 voices of normal subjects using Jitter, shimmer, ATRI, FTRI, Fftr and Fatr measures. The jitter, shimmer, FTRI, and Fftr measures were significantly higher in the group of subjects with Parkinson’s disease, suggesting that such measures possibly are more reliable to assess the tremor parameter in clinical practice.

Reliability of MDVP measures was also investigated by a study[1] that tested and retested the same voices and found high reliability for the frequency parameters; an acceptable reliability of jitter,

shimmer, noise, sub-harmonics and voice irregularity measures; and low reliability in tremor parameters. It also found that the parameters related to shimmer are more reliable than those related to jitter.

Concerning amplitude, a study [16] had the purpose of assessing the impact of prolonged reading on voice in two different levels of vocal sound pressure. The sample consisted of collecting sustained vowel [a] in usual tone, performed in three replications, with 50 female individuals and carried out in two sessions. In the first session the voice intensity ranged from 60 to 65 dB and in the second from 70 to 75 dB. The parameters assessed in MDVP were average f0, Jitter, Shimmer and NHR. The findings of this study indicated that average f0 rises as the voice intensity increases, while the voice quality decreases. Such findings confirm the importance of duration and intensity of vocal sound as factors of voice overload. These data were already known by clinic speech therapists, but the use of an objective evaluation enabled such corroboration.

Yet, according to literature some caution is necessary when using acoustic measurements. According to a study[17] NHR is considered the less reliable measure and the cepstral peak prominence (CPP) may vary according to gender.

According to some authors[17], understanding the intrapersonal variability in objective voice measurements, and if such variations result from biological differences or measurement error, the need for a standard test protocol should be considered. Thus, further studies covering the aspects of reliability of the MDVP software and measures are still necessary.

Comparison of MDVP with other acoustic analysis software

It is known that acoustic analysis programs use their own method to calculate f0, and although each one produces minor differences in the f0 mean value, to a greater extent it may influence the perturbation measures. This fact makes the clinical practice more difficult, because the programs that are available could show different values when they analyze identical voice samples[3]. Therefore, having full understanding of the differences between the programs and their measures is necessary to facilitate comparison and generalization of the results of studies using different programs and even to select the most suitable program to each situation.

Furthermore, it is not clear whether the normative data contained in the software (e.g., MDVP) are comparable with those obtained with other programs. Some researchers [3,18-20] have already observed such discrepancy between the results obtained by different programs.

A study[18] compared the jitter values found using Praat and MDVP programs. It was found that the threshold is greater in using Praat than in MDVP. Both programs are efficient and have comparable sensitivity when measuring small jitter values. This same study also compares the results obtained from AMPEX and BioVoice programs and found that BioVoice has the best performance in the analysis of jitter. This is because of the time of analysis that is possible with this program. However, another research found similar values for jitter when analyzed by MDVP and BioVoice[19].

In a research[20] conducted with women with and without functional dysphonia, similar results for f0 were obtained using MDVP and Praat programs. But for jitter, shimmer and NHR values, the results obtained by Praat were lower when compared to MDVP. This was different from the findings of another study [21], in which the shimmer values were similar, while jitter and NHR values were not similar. This highlights the need for further investigations on this matter, because by knowing the details of each software thoroughly it will be possible in the future to select the most appropriate program to suit the goals of the research to be conducted.

Another study[22] examined the use of a new proposed measurement for frequency perturbation called LocJitt, which provides better accuracy.This measurement was considered more reliable when used either with MDVP or with Praat. The only case in which Jitt exceeds the LocJitt measurement was when relative jitter was used in Praat. In all other cases the results obtained with LocJitt are similar or better than Jitt.

A study proposes a new method to estimate short-term jtter based on a mathematical model that describes coupling of two periodic phenomena. The proposed method measures such periodic movement indirectly, considering the spectral properties as a whole. The assessment was conducted with normal and dysphonic voice samples using two databases and jitter estimates from MDVP and Praat. The study showed that traditional methods really depend on the lowest frequency information, while the proposed method takes into account the entire spectrum. The study of short duration statistical jitter measures provided by the suggested method shows that there is a greater correlation with the voice pathology compared to the other two systems[23].

With respect to MDVP reliability, a research[10] compared its findings with the Voice Evaluation Suite (VES) program, analyzing voices of 50 children aged 4 to 17 years having no vocal alterations, and

obtained excellent reliability for f0 measures. In the conclusion, the authors reported that measures of sustained vowels could provide consistent frequency measures. But perturbation is not measured consistently, and the average of various samples of the same subject improves the result consistency. The WPCVox program showed similar results to those found with MDVP, and the frequency and amplitude perturbation values showed minor variation, with a difference within expectations. So, WPCVox is a program that allows comparisons with data analyzed by MDVP [24].

To date, the literature has shown that the most consistent measures that are in agreement with other acoustic analysis programs are those related to f0. On the other hand, the frequency and amplitude perturbation measures have some variance, and the users should be careful when comparing the results from studies on these measures.

Characterization of voices of different groups

There are studies in literature that seek to characterize acoustically voices of different groups of individuals. Among them, a study conducted a literature review describing and discussing the aspects involving acoustic vocal characteristics (of source and filter) of men with normal larynx. Such investigation concluded that the Jitt, ShdB and NHR values tend to be higher in men, while f0, PHR/HNR and ATRI tend to be lower than in women[5].

Another study described acoustic measures of 56 female, young adults with normal larynx and no complaints. The analysis showed that the measures with normal distribution were: f0; Jitter (local); Jitter (local, absolute); Jitter (ppq); Jitter (ddp). The Jitter (rap) measures, all Shimmer measures, the noise-to-harmonics ratio (NHR) and harmonics-to-noise ratio (HNR) did not follow normal distribution. From this finding it can be inferred that the measures that followed normal distribution are likely to be used as reference values for the interpretation of the results from female acoustic voice analyses, with or without laryngeal disorders. In addition, the study showed that all measures with or without normal distribution had similar results of those reported in national and international literature[4].

In the same line, a study [25] was conducted to verify the normal vocal acoustic characteristics of Arabs. The sample consisted of 300 Arabic-speaking Jordanians (100 male adults, 100 female adults and 10 children of both sexes). The MDVP program was used for f0 analysis of sustained [a] and f0 of speech of a produced sentence. The results revealed a significant difference among the f0 values of male, female adults and children. Comparison with other ethnic groups suggests that the f0 values of Jordanian male and female Arabic-speaking adults are in general consistent with the values of Caucasian and African adults. But for children the f0 values were relatively higher when compared to children of other languages.

This study [25] suggests that speech therapists in Arabic language specifically use the new data provided by the study in the assessment and/or treatment of Arab patients with speech disorders.

Also, an investigation sought to characterize vocal emissions from adult male patients with repaired post-foramen palatine fissure in a modal and basal recording. An acoustic analysis of glottal source in basal recording showed: f0 was within the speech modal register range and increased when compared to the emission in modal register; a large increase of measures that show frequency and amplitude variation; most of the jitter and shimmer measures significantly increased; increased measures of noise, voice breaks, unvoiced segments and tremor segments; SPI significantly reduced. This shows high emission instability and noise in basal recording in these subjects, likely due to weak intensity and reduced transglotic air flow[7].

MDVP still offers two measures of sub-harmonic segments, viz degree of sub-harmonic components (DSH) and numbers of sub-harmonic components (NSH). It is expected that subjects with normal voice have null values for both parameters, despite a small percentage of people, often women, who although may not have pathology of vocal folds, have sub-harmonic segments[12]. Thus, such measures appear less frequently in the literature, especially in studies with individuals without laryngeal disorders.

A study[12] that performed acoustic voice analysis in individuals with Huntington's disease found that both parameters (NSH and DSH) of frequency and amplitude perturbation had values significantly higher than the control group. In addition, these values had a significantly positive correlation with the degree of severity of the disease. Also, the number of voiceless segments or unvoiced segments (DUV and NUV) and the NHR, FTRI and ATRI measures also presented higher values for the group of subjects with Huntington's disease, when compared to the control group. However, the VTI and SPI values did not differ significantly between the two groups of the study. In addition, none of the tremor parameters, irrespective of frequency or amplitude, showed a significant correlation with the degree of severity of the disease.

Use of the MDVP system to verify the effect and effectiveness of different therapeutic procedures

Another category of studies compares the effects of voice techniques using acoustic analysis. In this context, a study [26] that used the voiced tongue vibration technique of speech therapy in 24 women observed immediately after performing the technique a significant increase of f0. Other studies that investigated vocal modifications occurring after using the techniques of fricative [ž] [27] and high-pitch sound [8] in women without vocal alterations did not find significant differences regarding the acoustic parameters analyzed via MDVP.

A study with 32 adult women without vocal complaints investigated the immediate effect of lips and tongue vibration and nasal sound vocal techniques, considered SOVTE (semi-occluded vocal tract exercises) and over-articulation. Using the MDVP system it was possible to determine a significant decrease of jitter and shimmer in the voices of the subjects [28].

Also, there are studies that aim to evaluate the efficiency or effectiveness of different voice therapeutic methods in case of subjects with dysphonia. Among them, a case study aimed to verify the effect of therapy with wind instrument in the phonatory function of patients with Parkinson's disease by means of acoustic voice analysis, which resulted in a reduction in the measures of Jita, Jitt, RAP, PPQ, sPPQ, ShdB, Shim, APQ, sAPQ, NHR after therapy[29], showing that such method provided positive results on the patients' voice.

With the purpose of determining the efficiency of the voice therapy, a study was conducted with 39 children who had vocal nodules, using the acoustic analysis and subjective evaluation. Each individual attended one therapy session per week during a period of three or six months. The evaluations were performed before and after the therapy, using MDVP and auditory-perceptual analysis based on the GRBAS scale. There was a significant improvement in four of five auditory-perceptual parameters and in the jitter (jitt), shimmer (shimm) measures, and in the noise-to-harmonics ratio (NHR). The study showed that acoustic analysis and GRBAS are useful evaluation tools in the comparison of therapies of children with vocal nodules [2].

A study[30] with women who had vocal polyps assessed the acoustic correlates of the vocal quality of these patients, before and after three weeks of endolaryngeal phonosurgery. To this end, ear, nose and throat (ENT) examinations and voice recording were performed. All acoustic parameters analyzed (vf0; Jitter; shimer; NHR; VTI; PPQ and APQ) improved significantly, and after the surgery they were similar to the reference values provided by the program. Therefore, the acoustic voice analysis is also suitable to compare voice in the pre- and post-surgical period.

A randomized study[31] examined the efficiency of a vocal training program in 36 teachers who had had vocal problems for more than three months, comparing the results with 22 individuals of the control group (without dysphonia). The therapeutic program had duration of four weeks and included vocal hygiene, vocal training with the yawn-sigh voice therapy technique, and guidance to perform the technique at home. The jitter, shimmer and NHR measures were analyzed. After administration of the therapeutic program there was a significant difference only in the NHR values.

Still regarding the use of MDVP to verify the effects of different therapeutic procedures, a group of elderly choral singers underwent a program of Vocal Function Exercises[32]. After training, MDVP showed that there was a significant improvement in the jitter, shimmer and NHR values. Such findings indicate that the program of vocal function exercises had a positive effect on the voices, and so they have the potential to attenuate the physiological effects of voice aging.

Some studies compare the effects produced in voice by different surgeries. Among them, a study[33] using MDVP found a positive effect in treating laryngeal symptoms, evidenced by a decrease of dystonic complaints and a reduction of the edema in the interarytenoid region after a medical intervention in a 55-year old patient with dystonia. The finding of this study [33] is in agreement with other researches [2,30,31] where the MDVP is used as a method to analyze effectiveness of therapeutic programs.

Another similar study used MDVP in a pre- and post-operative evaluation to release Reinke's space and in a specific surgical procedure, and also to compare long-term findings in patients who had benign vocal lesions. Based on the findings of the study it was possible to see that the use of the operative technique in analysis produced good vocal and laryngeal results in the patients. In addition, MDVP showed to provide progressive post-operative improvement during four years [34].

A study used the following parameters for MDVP analysis: mean values of f0, jitter, shimmer and NHR to determine the effectiveness of injection of laryngoplasty technique using calcium hydroxyapatite, comparing the cricotyroid (CT) approach with the thyrohyoid (TH) approach in patients with unilateral vocal fold paralysis[35]. The videostroboscopic, acoustic and auditory-perceptual parameters improved significantly after the injection using either the CT or the TH approach.

Another study with patients undergoing total thyroidectomy (TT) aimed to assess vocal functionality and swallowing in pre- and post-operative patients[36]. An acoustic analysis was conducted with four parameters: mean frequency of noise-to-harmonics ratio (NHR), jitter (%), fundamental frequency (f0) and shimmer (%). The result showed that the patients often have subjective complaints as the first symptom after TT. In addition, the laryngeal electromyography (LEMG) showed absence of subclinical lesion of the laryngeal nerve in all patients.

Literature also contains articles that compare the acoustic effects on the voice of subjects who underwent other treatments not directly related to the voice.

A study had the objective of assessing the acoustic changes before and after adenotonsillectomy in 40 children aged five to 24 years, with and hypertrophic adenoids and palatine tonsils, using the MDVP system, and compared them with 40 healthy children of the control group. The investigated parameters were average fundamental frequency (f0), Jitt, Shim, NHR, voice turbulence index (VTI), soft phonation index (SPI), degree of unvoiced segments (DUV), and degree of voice break (DVB). After the surgery of the group of study there was a reduction of all parameters under analysis compared to the control group, suggesting that the surgery provides improvement of the voice quality with reduction of the inadequate nasal resonance, even without voice therapy[6].

A study verified the effects of deep brain stimulation on the voice of 19 patients with Parkinson's disease, comparing them with a control group, i.e., 10 patients who did not agree in undergoing deep brain stimulation, and also with a group of 11 subjects without Parkinson's disease and who had normal voice. The results indicated improvement in the voice of the patients with Parkinson's disease treated with deep brain stimulation, showing that this method can be used to provide significant improvement in patients with severe vocal dysfunction [37].

Another study[14] investigated the effects of body hydration on vocal acoustic by analyzing the RAP and shimmer values and using the MDVP system. The sample comprised 38 female individuals aged 18 to 35 years. The subjects were evaluated in both the conditions of dehydration and hydration. For the first condition, the individuals were examined after 12 hours off liquids and foods. For the second condition, the individuals were examined after ingesting one liter of water for 20 minutes and waiting 70 minutes for the water to be absorbed by the body. Samples of sustained vowels for both conditions were collected and analyzed.

With respect to the findings of this study[14], the authors found a decrease (improvement) in all comparisons made in both dehydration and hydration conditions regarding the RAP and shimmer values. Thus, according to these findings, the effect of water on vocal acoustic is positive, even though no significant difference was found in all vowels comparisons.

In general, it is possible to see that MDVP is largely used when the purpose is to compare the effects of diverse treatments on the voice, and that it has been very effective in providing numerical data that reveal even the subtlest changes that a perceptual-auditory analysis would no be able to show.

CONCLUSION

The measures most commonly used by researches are f0, jitter, shimmer and NHR because they are considered the most important objective measures for assessing patients with voice disorders. On the other hand, tremor measures such as FATr and FFTr are measures that may fluctuate depending on the sample length and the positioning of measurement points for the analysis, and so they are not very reliable.

The literature shows that the most consistent measures that present high agreement with other acoustic analysis programs are those related to f0. But frequency and amplitude perturbation measures show some divergences, and some studies found variability when comparing the results with other programs.

Various studies sought to characterize different types of voices, such as those of subjects of both sexes without vocal alterations, in an attempt to establish a parameter of normality of different population groups. Such studies are very important in order to set parameters that define voice alterations via acoustic analysis. In addition, some studies characterize voices with different disorders.

The literature showed that acoustic analysis is an objective and necessary resource to assess patients with vocal disorders and, particularly, to compare different types of treatment. In addition, it can also be used in clinical practice as a tool for monitoring surgical procedures or in speech therapy. Based on the advantages in using acoustic analysis and the possibility of MDVP in analyzing diverse quantitative parameters, the use of this program can provide great benefits in the practice of speech therapy.

RESUMO

Este estudo tem como objetivo descrever, a partir de revisão de literatura, a confiabilidade da análise acústica utilizando o *Multi Dimensional Voice Program,* comparação de suas medidas com outros programas de análise acústica; caracterização de vozes de diferentes grupos; e sua utilização para verificar os efeitos e eficácia de diferentes procedimentos terapêuticos. Realizou-se levantamento bibliográfico que priorizaram estudos dos últimos cinco anos, incluindo-se artigos cujo objetivo estivesse de acordo com o interesse da presente revisão. A pesquisa foi realizada nos bancos de dados das bases *Lilacs*, BIREME, *PubMed*, *MedLine*, *Scielo* e *Google Schoolar*, por meio dos descritores *acoustic*, *speech acoustics* e *voice*. As medidas mais utilizadas são frequência fundamental, *jitter, shimmer* e proporção harmônico-ruído. As medidas de tremor não apresentam boa confiabilidade. As medidas mais consistentes que apresentam alta concordância com outros programas de análise acústica são as relacionadas com a frequência fundamental. Diversos estudos buscam caracterizar diferentes tipos de vozes tais como as de sujeitos sem alterações vocais de ambos os sexos, buscando estabelecer parâmetro de normalidade para diferentes grupos populacionais. Além disso, alguns estudos caracterizam vozes com diferentes distúrbios. A análise acústica é um recurso objetivo e necessário na avaliação de pacientes com distúrbio vocal e, principalmente, na comparação de diversos tipos de tratamento.

DESCRITORES: Voz; Acústica da Fala; Qualidade da Voz; Interface para o Reconhecimento da Voz; Acústica

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Mailing address:
Mara Keli Christmann
UFSM – Av. Roraima nº 1000 –
Cidade Universitária – Bairro Camobi
Prédio 26 – 4º andar –
Departamento de Fonoaudiologia
Santa Maria – RS – Brasil
CEP: 97105-900
E-mail: marakchristmann@gmail.com

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