Patients with disorders of consciousness: vital, facial and muscular responses to music or messages

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ABSTRACT

Purposes: to compare vital signs, facial expression and basal electroneurographic signs with measures during stimuli music, message or "silence" in coma patients, vegetative status or sedated; and relating the score of Glasgow Results Scale with the intervention realized. **Method:** a Monoblind Transversal Controlled Clinical Trial to researcher. The distribution, among the three groups, was randomized (experiment with music, experiment with message or control). Two assessments (sessions) were performed with interval of 40 minutes on the same day. **Results:** most of the 76 patients were male, between 18 to 36 years old and hospitalized due to trauma. Statistically significant changes were found in the variables referred to temperature, facial expression, electroneurography and Glasgow Results Scale; more frequent alterations in second session, in coma and vegetative patients, in frontal muscles and in experiment group. **Conclusions:** the facial expression and the electroneurography seem to be more trustworthy variables than vital signs to evaluate consciousness.
Key words: Consciousness Disorders; Vital Signs; Electromyography; Nursing.

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INTRODUCTION

Disorders of consciousness (DOC) are clinical situations in which there is diffuse psychological loss, and usually occur together with a general reduced or altered state of consciousness and impaired arousability. DOC include comas, vegetative states (VS), minimally conscious states, and sedation, disorders that present with some clinical differences[1].

A coma is a state in which individuals demonstrate no awareness of self or the environment, characterized by the absence or extreme reduction of behavioral alertness (level of consciousness). Furthermore, comatose patients are non-responsive to internal and external stimuli and lie with their eyes closed[1-2].

The term "vegetative state" was first coined in 1972 by Jennett and Plum to describe patients who "woke up" from comas (meaning that they opened their eyes spontaneously or when induced by stimulation), but who remained unaware of themselves and/or of the environment (meaning that they presented only some motor reflexes)[3].

In 2002, the Aspen Neurobehavioral Conference Workgroup published diagnostic criteria for identifying the minimally conscious state (MCS) used to sub-categorize patients in a vegetative state. Patients in an MCS are functionally incapable of communicating thoughts and feelings, but demonstrate (on a reproducible or sustainable basis) limited, but clearly discernable, evidence of awareness of self or of the environment[3].

Sedation is induced by central nervous system depressants being administered to reduce fear, anxiety, and/or agitation of critical patients. The need for sedation is based on the underlying pathological condition, primary treatment goals, physiological stress response, and presence of agitation or delirium[4].

The auditory perception and comprehension of patients with DOC has always been a matter of much debate, and, to this day, even with the advances in medicine and neuroscience, there is still no precise answer to the question of what happens in the minds of patients in this situation.

Assessing consciousness cannot be conducted in an all-or-nothing approach. Recovery of consciousness is a very gradual process. Sometimes, great improvements take place; however, most frequently, it is marked by subtle changes, as well as by some recovery regression[5].

Clinical evaluation of DOC patients is extremely complex and usually depends on subjective interpretations of the observed spontaneous and voluntary behavior. Thus, it tends to be vulnerable to diagnostic errors, especially as it depends on behavioral assessment[6]. Considering this limitation, it is important to investigate more sensitive and reliable tools or clinical signs that can detect subtle signs of recovery of consciousness[5].

Another unyielding limitation when it comes to ascertaining patient consciousness is the fact that vegetative patients may move to a great extent, and clinical studies are faced with the difficult task of differentiating autonomic or reflex movements from voluntary ones. This frequently leads to underestimation of behavioral signs of consciousness, and, consequently, to misdiagnosis[7].

Standardized neurobehavioral assessment is one of the most sensitive forms of establishing a differential diagnosis in patients with DOC, as compared to diagnoses determined by clinical consensus. However, despite the importance of diagnostic accuracy, the rate of diagnostic errors related to VS has not changed substantially in recent years[8].

Accordingly, it is of utmost importance for DOC patients that medical and nursing teams adapt their assessment of the level of consciousness and that they gain a deeper understanding of human consciousness and the relevant role of the mind in processes of vital re-equilibrium. Not only would this help minimize the anxiety experienced by such professionals in many cases, but it would also help extend their interventions beyond physical care and the technical control of monitoring equipment, seeking to reach other human dimensions[9].

Particularly, providing nursing care to DOC patients is a challenge; the research on this topic in the field of nursing in Brazil is limited[10-16], and many issues remain to be studied.

Thus, the objectives of the present study were (1) to measure and compare the vital signs, facial expressions, and baseline electroneuromyographic (ENG) signs of coma, vegetative, or sedated patients exposed to stimuli consisting of music, a message, or "silence" (control) and (2) to assess the changes in the Glasgow Coma Scale (GCS) scores associated with the conducted intervention.

METHODS

This was a cross-sectional controlled clinical trial blind to researcher. The intervention consisted of exposing patients to their favorite style of music, as indicated by family members, and oral messages (independent variables). The outcome indicators were alterations in vital signs, facial expression or muscle tone (dependent variables). The study occurred in two Intensive Care Unit (ICU) and an inpatient care at a public hospital in the city of São Paulo, Brazil.

The inclusion criteria were as follows: (1) patients aged 18 years of age or older; (2) a medical diagnosis of coma, VS, or clinical sedation; (3) a GCS score between 3 and 8 for coma/VS patients and R5 or R6 on the Ramsay Sedation Scale (RSS) for sedated patients; (4) length of hospital stay greater than 48 hours; and (5) preserved previous auditory function according to the family (i.e. deaf individuals or those previously diagnosed with impaired hearing were excluded). We adopted the following exclusion criteria: (1) suspected or confirmed diagnosis of brain death, (2) patients with total or upper-limb paralysis or paresthesia, and (3) patient with upper-limb edema.

The patients were randomly assigned to one of three groups: experimental 1 (music), experimental 2 (message), and control ("silence"). Only the experimental groups received intervention.

The purpose of the oral message was twofold: to expose patients to a language stimulus and to help focus their attention. Some standardization criteria were used to produce the intervention; the messages had to: (a) be produced and vocalized by

a family member or someone who was part of the patient's daily life, (b) be two to four minutes long, (c) mention who was speaking at the beginning and end of the message, (d) say the patient's name at least three times throughout the message, (e) inform the patient as to their whereabouts (where they were and what was happening to them), and (f) express a caring and optimistic message, telling the patient something about their family life.

The music used for the intervention was selected by the family members, according to the patient's preference. The goal of using music was to expose the patients to a stimulus with a certain level of affective connection, in addition to providing comfort.

Family members were asked about the patient's favorite musical style and were instructed to select a song from a preset list of 98 songs, all 2-4 minutes long, divided into 8 musical styles (Brazilian popular music, Brazilian country music/baião, samba/chorinho, international music, movie themes, new age, classical, and gospel/evangelical).

The patients were randomly assigned to one of the three research groups using the following protocol: a researcher responsible for the random distribution of patients selected what content would be recorded on the CD (music, message, or silence) for each patient. Randomization was conducted in blocks of two to four patients in order to achieve even distribution among the groups. Another researcher conducted the tests and was blind to the previous distribution. The control stimulus consisted of an audio recording of "silence" (ambient sound with no prior verbal instruction) on a digital voice recorder, which was later recorded on a CD.

This study was approved by the Research Ethics Committee (protocol no. 0888/07). Data collection was initiated by approaching family members during the hospital visiting hours soon after the patients were admitted to the ICU. Those who voluntarily agreed to participate signed an informed consent form. Subsequently, they were asked to select a song, and, after visiting hours, to record the oral message in a reserved area of the ICU. Data collection was performed between August 2008 and September 2009.

In the next phase, the patients were assigned to one of the three groups as described above, and CDs were recorded with music, a message, or "silence." On the following day, the experiments were conducted. Two assessments (sessions) for each patient were conducted on the same day, interspersed by a 40-minute interval.

The patients were initially assessed using the GCS or RSS, depending on the etiology of the DOC. Next, the pupil and baseline respiratory parameters were evaluated and recorded. Electrodes were positioned on the frontalis muscles (channel 1), a hand extensor muscle (channel 2), and a bony prominence (zero point), and earphones were placed on the patient. The acoustic stimulus was set at a volume between 60 and 70 decibels. The time of stimulation for measuring data was controlled using the CD player's digital display and a portable camera was positioned so as to focus on the patient's face. Muscle tone was measured using ENG equipment, ENG signal acquisition software (Miograph, Miotec), and a portable computer. Baseline vital signs, ENG signals, and facial expressions were collected before the intervention, and, finally, the tester played the selected CD and the same variables were collected while it played.

The vital signs were measured and recorded at three separate moments: baseline, after 30 seconds and after a minute and 30 seconds, in a pre-established sequence (heart rate, temperature, SaO_2, and blood pressure). ENG signals were measured continuously and recorded at two different moments: at baseline (first 20-40 seconds) and while the CD played (first 110-240 seconds).

Facial expressions were filmed for posterior analysis together with ENG signals, as both variables were captured and visualized by the same acquisition program. These were analyzed with regards to whether or not there was any alteration of the baseline facial expressions, i.e., expressions or alterations already displayed during the baseline period were not considered. Facial expressions were assessed in terms of mouth, head, and eyebrow movements; facial tension or relaxation; tears; and unspecific eye opening.

All patients were assessed with the GCS 30-40 days postintervention, which did not necessarily correspond to 30-40 days following the traumatic injury.

The data were stored using Excel for Windows Explorer® software and analyzed with SAS® version 9.1.3. We employed descriptive and inferential statistical analyses and p-values < 0.05 were considered statistically significant. The normality of data distribution was assessed using the Kolmogorov-Smirnov test. If the data presented normal distributions, parametric tests were applied; if not, non-parametric tests were employed. For comparisons, the Kruskal-Wallis, Wilcoxon Signed-Rank, Mann-Whitney, Fisher's Exact, or Chi-Square Test were used.

RESULTS

Of the identified 157 patients, 76 were included in the final analysis. The reasons for exclusion included brain death (n = 35), loss of data during the collection due to a change in the state of consciousness (n = 19), family refusal (n = 9), death (n = 5), patients with no family or guardians (n = 4), tetraplegia (n = 4), upper-limb edema (n = 3), and lack of patient identification (n = 2).

The 76 comatose (n = 26), VS (n = 13), or sedated (n = 27) patients had a mean ± standard deviation age of 42.5 ± 19 years. Of these, 47.3% (n = 36) were young adults aged between 18 and 36 years; 73.7% (n = 56) were male, and the main reason for hospitalization was traumatic injury (n = 63; 82.9%). Regarding the kinship of the individuals who recorded the messages, most were spouses (n = 24) and children (n = 20) to the patients.

The coma or VS patient subgroup presented a mean GCS score of 4.6 ± 1.5 points. The most frequent GCS scores were 3 (n = 17; 43.6%) and 6 (n = 15; 38.5%). Regarding the RSS, sedated patients obtained a mean score of 5.5 ± 0.5. Of the 37 sedated patients, 17 (45.9%) scored R5 and 20 (54.1%) R6.

The patients were distributed among the groups in the following frequency: control group (n = 20; 10 in a coma/VS and

10 sedated), music experimental group (n = 30; 16 in a coma/VS and 14 sedated), and message experimental group (n = 26; 13 in a coma/VS and 13 sedated).Two forms of data analyses were conducted: comparison of all patients by intervention group (music, message, or control) and comparison of patients in different clinical conditions or etiology of DOC separately (coma/VS or sedated) according to the intervention groups (music, message, or control) (Table 1).

Of the eight statistically significant alterations observed in the entire DOC patient sample, music caused the most intense changes in five of the studied variables (p = 0.016; 0.027; 0.014; 0.034; 0.041), and messages in two (p = 0.034 and 0.015). Comparison of the ratios categorized by muscle tone relaxation, tension, or no alteration showed that both music and message caused muscle tension, rather than relaxation, in DOC patients (p = 0.032).

Table 1 – Descrição dos RESULTS estatisticamente significantes nas comparações entre os grupos de intervenção e variáveis dependentes do estudo, São Paulo, 2008/2009

Comparison description	Variable/Interval/Session	Control (n = 20)	Music (n = 30)	Menssage (n = 26)	p-value
All patients					
Between baseline vital sign measurements and during evaluation of each individual group	SAT / 30″ / Session 1			B: 95.2 ± 4.1I: 93.9 ± 6.3	**0.034****
	T / 30″ / Session 2		B: 36.2 ±1.5 I: 36.3 ±1.4		**0.016****
	T / 1′30″ / Session 2		B: 36.2 ±1.5 I: 36.2 ±1.5		**0.027****
Between intervention groups and alterations in facial expressions	Facial expression / 90-110″ /Sessions 1 and 2 together	No.; % N/A: 20; 100 A: 0; 0.0	No.; % N/A: 24; 80 A: 6; 20	No.; % N/A: 18; 69.2 A: 8; 30.8	**0.015*****
Between intervention groups and categorized ratios of rms values (ENG signal)	ENG – channel 1 / Session 2 / 90-110″	Mean ± SD 0.94 ± 0.12	Mean ± SD 2.19 ± 6.13	Mean ± SD 1.17 ± 0.39	**0.014***
	ENG – channel 2 / Session 1 and 2 together / 30-50	Mean ± SD 0.95 ± 0.02	Mean ±SD 1.07 ± 0.06	Mean ± SD 1.02 ± 0.03	**0.034***
Between intervention groups and ratios categorized by relaxation, tension or no alteration in muscle tone	ENG – channel 1 Ratio: 90-110/Baseline Session 2	No.; % R: 12; 60 N/A: 1; 5 Ts: 7; 35	No.; % R: 11; 36.7 N/A: 1; 3.3 Ts: 18; 60	No.;% R: 5; 21.7 N/A: 0; 0.0 Ts: 18; 78.3	**0.032*****
Between intervention groups and Glasgow Coma Scale score	GCS	Mean ± SD 2.1 ± 0.6	Mean ± SD 2.3 ± 0.8	Mean ± SD 1.9 ± 0.5	**0.041******
Patients in a coma or vegetative state					
Between intervention groups and alterations in facial expression	Facial expression / 90-110″ / Session 1 and 2 together	No.;% N/A: 10; 100 A: 0; 0.0	No.; % N/A: 11; 68.8 A: 5; 31.3	No.; % N/A: 7; 53.8 A: 6; 46.2	**0.036 *****
Between intervention groups and ratios categorized by rms values (ENG signal)	ENG – channel 1 Ratio: 90-110/Baseline / Session 2	Mean ± SD 0.9 ± 0.1	Mean ± SD 1.3 ± 0.5	Mean ± SD 1.1 ± 0.4	**0.007 ***
Between intervention groups and ratios categorized by muscle tone relaxation, tension, or no alteration	ENG – channel 1 Ratio: 90-110/Baseline / Session 2	No.; % R: 7; 70 N/A: 1; 10 Ts: 2; 20	No.; % R: 4; 25 N/A: 0; 0.0 Ts: 12; 75	No.; % R: 3; 23.1 N/A: 0; 0.0 Ts: 10; 76.9	**0.019 *****

Table 1 (cont.)

	Sedated patients				
Between intervention groups and ratios categorized by muscle tone relaxation, tension, or no alteration	ENG – channel 2 Ratio: 30-50/Baseline / Session 1 and 2 together	No.; % R: 8; 80 N/A: 0; 0.0 Ts: 2; 20	No.; % R: 9; 64.3 N/A: 0; 0.0 Ts: 5; 35.7	No.; % R: 4; 30.8 N/A: 0; 0.0 Ts: 9; 69.2	**0.047*******

Testes estatísticos: *Teste de Kruskal-Wallis; **Teste de Wilxocon Pareado; ***Teste Exato de Fisher; ****Teste de Mann-Whitney; *****Teste de Qui-Quadrado.
Abreviaturas: *DP (desvio-padrão); SAT (Saturação de oxigênio); T (Temperatura); ERGl (Escala de Resultado de Glasgow); B (basal); I (intervenção); S/A (sem alteração); A (alteração); R (Relaxamento); Ts (Tensão).*

Three statistically significant changes among patients in a coma or VS were observed. First, most alterations in facial expression occurred during the message intervention ($p = 0.036$); second, the mean ENG signal was greater among patients exposed to music ($p = 0.007$); and third, comparison of the ratios of muscle tone relaxation, tension, or no alteration among the intervention groups showed that there was greater muscle tension in patients exposed to either music or messages ($p = 0.019$).

Interestingly, among the sedated patients, the effects of the music and message interventions were the opposite: music caused relaxation and messages produced tension ($p = 0.047$).

The temperature; facial expression; channel 1 ENG, which corresponds to the frontalis muscle; and GCS score stood out as variables that displayed statistically significant results in this study. Such findings point to the importance of behavioral observation and of non-verbal communication when assessing consciousness of DOC patients.

Assessment with the GCS revealed that most patients were in a persistent vegetative state (n = 45; 59.2%). The other patients presented severe disability due to motor and/or cognitive deficits (n = 17; 22.4%), death (n = 13; 17.1%), and moderate disability due to motor and/or cognitive deficits (n = 1; 1.3%), indicating that none of the patients presented good recovery when assessed 30-40 days post-intervention.

DISCUSSION

Several studies on DOC patients have been conducted by researchers in different forms and using different variables, owing to the fact that there is currently no gold standard for assessing such patients. The use of vital signs, facial expressions, and ENG signals as variables has emerged from the need for more affordable and accessible means for evaluating consciousness.

Undoubtedly, clinical assessment of DOC patients is extremely complex and new diagnostic means must continue to be researched; however, the results of this study, especially when assessing the patient groups separately, point to a current trend of recognizing the greater reliability of assessments based on behavioral observation. Motor limitation is an important factor, but considering the results of this study, facial expressions and ENG seemed to be reliable variables for measuring consciousness.

Researchers in a previous study[10] assessed the vital signs and facial expressions of DOC patients. The results converged with those of this study regarding the statistically significant responses in facial expressions between the control and experimental groups, both for the music ($p = 0.01$) and message interventions ($p < 0.001$). Nonetheless, the results were limited with respect to vital signs, likely owing to the limited sample size. Finding patients that meet all inclusion criteria is an important limitation for research on DOC; however, such important clinical variables must not be discarded or disregarded due to this limited inference. Considering these challenges, the study was replicated herein in an attempt to reduce bias, use an increased sample size, and include another variable, namely ENG.

Vital signs are valuable measurements in clinical practice and demonstrate the functioning and alterations of body function. Nursing teams record the vital signs daily, and the frequency of such records depends on the severity of the patient's condition and location of hospitalization. The vital signs of DOC patients have always been subject to question, especially by family members, with regards to whether or not alterations are a form of patient communication. People who have a family member with DOC hospitalized in the ICU frequently report that when talking to the patient, alterations of the vital sign measurements are observed on the hemodynamic monitoring equipment.

Measuring vital signs as an indication of response to some intervention has been used by many studies. However, most responses have proven to be inconclusive, and this may be related to the way in which vital signs are collected; taking one-off measurements and using traditional equipment does not seem to be the best option for measuring these variables; however, this method tends to the most readily and frequently available[17].

The significant results regarding the vital signs in this study occurred at two moments, with the body temperature during the intervention being altered in both experimental groups with respect to the baseline. Increased body temperature and even facial flushing can occur due to emotional arousal[18]. The face is a region that people are generally highly aware of and frequently attempt to actively control. Emotions can be detected by quick and subtle signals in different regions of the face, such as muscle movements; muscle tone, temperature, and skin color changes; sweating; and pupil dilation[19]. Each

emotion generates a unique pattern of body sensations with specific signals, especially in terms of the physiognomy and voice. In the same way as there are different expressions of anger, fear, aversion, sadness, and joy, there are also different profiles and physiological changes in the organs that generate unique feelings related to each emotion[20].

A case study conducted with a young comatose male patient 42 days post-trauma demonstrated application of such vital signs as a measurement variable. The objectives of this case study were to determine (1) the patient responsiveness when exposed to four types of auditory stimuli, namely voices of family members and friends, classical music, popular music (rock and roll – the patient's favorite style), and nature sounds, and (2) what physiological measurements and behavioral observations best captured the changes in responsiveness. The data were collected over 14 consecutive days (two 20-minute sessions per day for a total of 28 sessions). During all sessions, the pulse, respiration rate, and skin resistance were verified. Only one of the four types of stimuli was presented at a time, in a randomized order. Compared to the other auditory stimuli, the taped voices of family members and friends produced greater increases in the pulse and respiratory rate compared to the baseline measurement, as well as the greatest number of body movements. In general, the three other stimuli showed minimal effects for the pulse and respiration rate, with rock and roll music predominately showing negative changes (below the baseline) in both situations[21]. Similarly, another study[20] also emphasized messages or voices of family members and body movements or ENG signals as important variables that can reveal responsiveness in such patients. Even though music more frequently correlated with statistically significant alterations in the present study, the power of verbal stimulation in these situations is undeniable[21-23] and further research must be conducted to reach more concrete conclusions regarding the benefits of music vs. messages.

Some studies that use messages or the patient's own name have obtained really interesting results with DOC patients. In one previous study, the effect of intervention with voices of family members was studied with comatose head-injured patients. The study monitored the physiological parameters (intracranial pressure, blood pressure, pulse rate, respiratory rate, mean blood pressure, and oxygen saturation) of 10 patients with a GCS score ≤10. The messages produced by family members followed a set model, lasted 60 seconds, and were repeated 3 times (for a total of approximately 3 minutes). The experiment was performed as follows: five minutes before the intervention, baseline data were collected; subsequently, the message was played (continuous physiological measurements were obtained, the mean for each physiological parameter was calculated, and the presence or absence of agitation was documented), and five minutes after the message, all measurements were taken once more. The intervention was repeated four times with a six-hour interval between each session. Data analysis revealed only one change in the physiological measurements; however, no statistically significant differences were found between the means obtained before, during, and after the message. Of all physiological parameters, the pulse

rate was the measurement that varied the most[22]. Of note, although previous studies[21-22] have found the pulse rate to be the vital sign with the greatest variability of the physiological parameters, we did not obtain the same result in the present study.

In addition to using messages and voices of family members, saying the patient's name has been recognized as another stimulus that can be effectively apprehended by DOC patients. Name sequences containing the patient's own name and that of others were presented to 8 VS and 14 MCS patients in passive and active conditions in one previous study. In the active condition, the patients were instructed to say their own name or another target name. Like the controls, patients in an MCS presented a greater P3 (the third positive wave of event-related potentials, also called the P300) to their own name in both the passive and active conditions. Furthermore, the P3 for the target stimuli was greater in the active compared to passive condition, suggesting voluntary compliance with task instructions. Such responses were observed even in patients with low behavioral responses (for example, visual fixation and pursuit). Conversely, no differences in the P3 between the passive and active conditions were observed for patients in VS. These results suggest that active event-related potentials can detect voluntary brain function in patients with severe brain damage who present with DOC[23]. However, the P3 is not a reliable marker of consciousness, and this variable should hence be used cautiously[3].

Sedated patients are also considered DOC patients, and the same questions emerge regarding auditory perception, linguistic processing, and cognition while in this clinical condition. In the study by Davis et al., magnetic resonance imaging was conducted on volunteers in three clinical conditions – non-sedated, lightly sedated with propofol, and deeply sedated with propofol. The participants were exposed to sentences containing ambiguous words, sentences without ambiguous words, and noise during three scanning sessions. Bilateral temporal-lobe responses to the sentences compared with noise were observed at all three levels of sedation, although there were no prefrontal and premotor responses at the deepest level. Additional posterior temporal and inferior frontal responses to ambiguous sentences provided a neural correlation with the semantic processes critical for comprehending sentences that contain ambiguous words. However, this additional response was absent in light sedation, suggesting that sentence comprehension was markedly impaired. A significant decline in post-scan recognition memory was also observed, suggesting that sedation impairs the sentence encoding into memory, with the left inferior frontal and temporal lobes responses while under light sedation predicting the subsequent recognition memory. These results suggest a graded degradation of cognitive function in response to sedation in such a way that "high-level" mnemonic and semantic processes can be impaired at relatively low levels of sedation, whereas processing of perceptual speech remains resilient even during deep sedation[24].

Music can also be considered a relevant stimulus for patients, especially when endowed with emotional value and meaning. It has been used as recourse in studies with DOC

patients and has frequently revealed favorable results. Music can access the most subtle and effective communication structures and such subtlety is fundamental when caring for patients with altered consciousness. In the study by Aldridge et al., the effects of music therapy was tested on 5 patients with consciousness alteration. The intervention consisted of improvised wordless songs sung by a therapist who monitored the patients' pulse and respiratory rate. Each session with the music therapist lasted a maximum of 8–12 minutes. The characteristic of the patient's breathing determined the essence and rhythm of the song. A range of reactions were observed: breathing changes (slower and deeper), fine motor movements, grabbing movements of the hand and turning of the head, eyes opening, and reduced heart rate, suggesting an attempt at orientation and cognitive processing within the communicational context[25].

In another study, the effects of specific sensorial inputs on the cortical activity of 5 coma patients were examined. The patients were assessed using the GCS; the behavior and electroencephalogram were observed and recorded with and without auditory stimuli during 7 days of monitoring. Four to six weeks later, behavioral data were collected along with the GCS. For the intervention stimuli, two pre-selected popular songs were used. The results indicated that the coma patients were able to respond to the auditory stimuli. However, the responses were varied within the small sample and were thus inconclusive from a scientific point of view, although the authors concluded that some type of response did indeed occur. Two patients showed a response on electroencephalogram and the other three responded by opening their eyes or by extremity movement[26].

Another less studied, albeit promising, instrument for measuring responsiveness among DOC patients is electroneuromyography (EMG). Using hand EMG, one previous study observed the occurrence of sub-threshold muscle activity in response to a verbal command as an objective indicator of awareness in 10 patients with DOC. One of the eight VS patients and both MCS patients demonstrated increased EMG values specifically linked to the verbal command, indicating that the EMG could potentially be used to objectively assess consciousness in these pathologies[27].

Additionally, a very unconventional study used Pavlov's classical conditioning theory and EMG on DOC patients. Pavlovian conditioning is contingent on the temporal gap between conditioned and unconditioned stimuli and can be considered an objective test for assessing awareness. The study found that even though DOC patients cannot report awareness explicitly, they were able to learn this procedure. Learning was specific and demonstrated an anticipated EMG response to the conditioning stimulus, which was substantially stronger than that to the control stimulus. The amount of learning correlated with the degree of cortical atrophy and was considered a good indicator of recovery. None of these effects were observed in control subjects under anesthesia with propofol, suggesting that the individuals with DOC may have partially preserved conscious processing that cannot be made explicit and is not detected using behavioral assessment[28].

In yet another study, skin conductivity responses to emotional and neutral auditory stimuli were recorded in 13 low-responsive patients, including 12 coma patients. The results showed a differential response between the emotional and neutral stimuli, with significant correlations with the GCS and Cook and Palma scores. These correlations indicate that emotional processing can occur in coma patients with relatively high clinical reactivity scores. The researchers also tested if coma patients and other low-responsive patients could display emotional responses and if such responses could be measured through skin conductivity. The data suggested a small but significant skin conductivity response of some patients, and this response decreased as the level of consciousness decreased[29]. Furthermore, the present study found significant differences with respect to the ENG findings after the interventions. However, further studies on specific types of patients should be conducted with this variable.

Taken together, the results of the current study suggest that family messages or bedside conversations, as well as music, may be important for patient recovery and as part of the care provided to the family. Nursing care for DOC patients requires knowledge, competences, and skills specific to nurses, as well as particular care-focused actions and planning. It is important for nurses to continuously seek professional development and be up to date on DOC patient care, especially with regards to the perceptual capacity, diagnostic criteria, and signs of increased consciousness, areas in which recent discoveries have been made due to advances in the field of neuroscience[11-12].

When alert to the signs of consciousness, nursing teams can, and must, contribute relevant information for assessing consciousness, especially because of the greater and more intense contact that these professionals have with patients compared to other team members. Due to its complexity and subtlety, there is no doubt that assessment of consciousness is a multidisciplinary issue.

CONCLUSIONS

Increased body temperature and facial flushing may be indicators of emotional arousal among DOC patients and should be further studied in the future. Facial expressions and ENG signal seem to be more reliable than vital signs as variables for measuring consciousness. Taking into account that facial expressions present with subtle alterations that require attention, repetitive observation, and even the possible reduction of video speed by researchers, the use of recordings is indispensable for such assessments. Conversely, the use of vital signs measured at pre-determined intervals of time is not recommended for assessing awareness in patients with disorders of consciousness.

In the present study, for all patients with DOC, regardless of the etiology of unconsciousness, music seemed to be the more intense stimulus, whereas the differences with regards to messages were relatively slight. Both music and messages caused muscle tension in DOC patients instead of relaxation; however, among sedated patients, music caused relaxation and the use of a recorded message produced tension.

Limitations of the study and implications for nursing

Limitations of the present study and its sampling include: (1) the approval and implementation of the Brazilian law against drunk driving, which considerably reduced the number of motor vehicle crash patients and the severity of victims that arrived at the hospital during data collection; (2) a long-lasting renovation of the two ICUs chosen for this study, which resulted in patients being hospitalized in other hospital units non-authorized for the study; and (3) the H1N1 flu outbreak in the state of São Paulo, which reduced and restricted hospital visits and their duration, making it difficult for the researchers to access family members to authorize the participation of the patients in this study.

Regarding the vital signs, the choice for one-off measurements was a methodological strategy; however, it was not the researchers' first choice. It would have been more appropriate to obtain equipment that measured vital signs continuously. It is also known that some patients with DOC can present severe motor impairment and thus reduced capacity of facial expression; however, such alterations are hard to identify and currently constitute one of the main issues concerning the behavioral assessment of such patients.

Despite the limitations and challenges associated with research efforts on the topic, the present study clarified important issues related to the care of DOC patients, as well as signs and behaviors that can be identified by the nursing team, aiding in the clinical diagnosis. Caring for DOC patients is a complex issue that involves both constant professional learning and development as well as involvement and sensitivity to identify subtle signs of recovery of consciousness among these patients.

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