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EFFECTIVENESS OF FAMILY-CENTERED AUDITORY AND TACTILE SENSORY STIMULATION ON LEVEL OF CONSCIOUSNESS IN TRAUMATIC BRAIN INJURY PATIENTS

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ABSTRACT
TBI patients with decreased consciousness will experience decreased sensory and stimulus perception as a result of prolonged hospitalization, immobilization, and social isolation. Therefore, sensory stimulation is needed to increase patient awareness. This study aimed to determine the effects of family-centered auditory and tactile sensory stimulation in patients with TBI. A case study was used to describe the intervention in this study. The study sample was an adult patients with TBI admitted to the intensive care unit. The trained family members provided auditory and tactile sensory stimulation once daily for 1 week. Two instruments were used for data collection, the "Glasgow Coma Scale" and the "Fall Outline of Unresponsiveness Score" to assess the patient's level of consciousness (LOC). The results showed that implementing organized auditory and tactile sensory stimulation by trained family members was increased the average GCS and FOUR score. Patients in this study showed an increase in LOC with a GCS score of 8-14 and FOUR score of 9-14 on 7 days of intervention. Thus, auditory and tactile sensory stimulation by trained family members enhanced the consciousness of patients with trauma-induced brain injury. This method is recommended for patients with traumatic brain injury.

Keywords: consciousness; family-centered; sensory stimulation; traumatic brain injury

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INTRODUCTION

Traumatic Brain Injury (TBI) caused by accidents is associated with death and disability (Centers for Disease Control and Prevention, 2019). The severity of TBI ranges from mild (a brief change in mental status or consciousness) to severe (an extended period of unconsciousness or amnesia) (Centers for Disease Control and Prevention, 2019). All TBI cases ranging in severity from mild to moderate severity are serious and can cause long-term consequences. Therefore, most patients with moderate to severe TBI require treatment in the Intensive Care Unit (ICU) (Stocker, 2019).Globally, the incidence of TBI varies annually, with estimates ranging from 27 million to 69 million new cases (Dewan et al., 2019; James et al., 2019). According to the Indonesian Health Data Survey in 2023, the second highest cause of disability in Indonesia is accidents/injuries, with the highest province being the Riau Islands at 51.7%, while East Java at 21.8% (Badan Kebijakan Pembangunan Kesehatan, 2023). According to (Waraztuty et al., 2022), 85% of TBI cases are correlated with death

within the first 2 weeks after injury. Furthermore, traffic accidents and falls are the most common causes of TBI (Waraztuty et al., 2022).

Patients with TBI experience changes in consciousness over time. Impaired consciousness in TBI begins with minimal awareness and progresses to coma, vegetative state, and even brain death (National Institutes of Health, 2020). Furthermore, patients with decreased consciousness experience decreased sensory perception and stimulus due to prolonged hospitalization, immobilization, and social isolation (Abbasi et al., 2009). Some signs and symptoms of sensory perception in TBI patients include: dizziness, vertigo or loss of balance or coordination, blurred vision, bad taste in the mouth, sensitivity to light or sound, mood swings, agitation, aggression, feelings of anxiety or depression, fatigue or sleepiness, and lack of energy or motivation (National Institutes of Health, 2020). Furthermore, decreased consciousness that lasts for days is a bad sign for TBI patients, including death and disability (Kowalski et al., 2021). Thus, intervention is necessary to provide sensory stimulation to increase patient awareness.

Sensory stimulation provides sensory stimulation in the form of visual, auditory, tactile, gustatory or olfactory (Septiany et al., 2019). Providing auditory and tactile sensory stimulation based on Family-Centered Care (FCC) can increase awareness and meaningful behavioral responses in head injury patients (Sedghi & Ghaljeh, 2020). Auditory stimulation involves listening to sounds from nearby people or listening to music. In patients with decreased consciousness, the last sense that functions well is hearing (Septiany et al., 2019). Furthermore, nonverbal communication is considered effective in patients with decreased consciousness. Tactile stimulation can induce positive feelings, such as relaxation, security, and affection, as well as negative feelings, such as anger and aggression (YekeFallah et al., 2018). Tactile stimulation is also considered safe, effective, practical and simple for eliminating patient anxiety reducing pain and anxiety without dangerous side effects (Sedghi & Ghaljeh, 2020). According to (Ahmed et al., 2023), auditory and tactile sensory stimulation has received more attention in TBI patients than other senses because it is considered a safe and effective measure, and the response is easy to observe.

Assessment of consciousness in clinical settings generally uses the GCS score, but the GCS has several weaknesses, such as opening the eyes spontaneously in a vegetative state; verbal response cannot be assessed in patients with aphasia, endotracheal implants, or orofacial trauma, and not assessing the overall anatomy related to consciousness (Kalita & Misra, 2019). Therefore, in 2005, the FOUR Score was developed by Wijdicks et al. to address the weaknesses of GCS (Kalita & Misra, 2019). However, research on auditory and tactile sensory stimulation using the FOUR Score is limited. Therefore, researchers intend to implement tactile and auditory stimuli to change FOUR and GCS score values in patients with TBI in the ICU. This study aimed to determine the effects of family-centered auditory and tactile sensory stimulation in patients with TBI.

METHOD

Using a nursing care approach, this study used a case report to describe the clinical observations in a healthcare delivery setting.The study population included all patients with TBI admitted to the Public Hospital in Indonesia, from March 24th until April 04th, 2024. Inclusion criteria consist of age between 18 and 45 years, TBI approved by a neurologist, GCS score 6–8, and coma caused by TBI. Patients who are taking narcotics are excluded.The sample in this study was an adult aged 20 years who had TBI and was unconscious and was treated in the ICU at Public Hospital. A consecutive sampling approach was used to select

patients based on inclusion and exclusion criteria.The independent variable in this study was the implementation of family-centered auditory and tactile sensory stimulation. Meanwhile, the dependent variable was TBI patients' level of consciousness. Two tools were used to collect data in this study, the Glasgow Coma Scale (GCS) and the Fall Outline of Unresponsiveness Score (FOUR Score) to assess patient's level of consciousness (LOC).

The study was conducted for 7 days, from March 28th until April 03rd, 2024. Written informed consent was obtained from the families of eligible patients who expressed their willingness to participate in this study. The researcher then met with his family members and asked them to introduce someone with whom they had the greatest contact, depended on the patient, and had no psychological problems (the person appointed by the family was fixed during the study). Then, the selected family member received the necessary training on how to wash hands and perform auditory and tactile sensory stimulation, which included introducing themselves to the patient, calling the name three times, informing them of the time and place, and telling them happy memories near both ears. Additionally, tactile stimulation included palpation of the patient's wrist and palm from the wrist to the nail. All instructions were offered in practice, and the intervention was performed after coordination with the head nurse and nurse. 5 min before the interventions, the demographic form was completed, and the patient's LOC was measured using the GCS and FOUR Score. Then, under the researcher's supervision, the family member performed the intervention based on the instructions, which included simultaneous auditory and tactile stimulation, first on one side and then on the other for 10 min. LOC was re-measured 30 min after sensory stimulation. The intervention was conducted for seven consecutive days in the evening shift (16.00-18.00 o'clock).Deviant data were collected and then analyzed according to the etiology to identify nursing problems. Furthermore, nursing problems are arranged into nursing diagnoses and then prioritized based on the patient's condition. Nursing care plans are prepared based on research evidence.

RESULTS

Diagnostic Assessment

Mr. R, 20 years old, has traumatic brain injury and unconsciousness. On March 27th, 2024, at 07.09 p.m., the client was taken to the emergency room (ER) at Public Hospital, with the main complaint being unconscious. Current illness history: After falling alone on a motorbike, wearing a helmet, came with complaints of being unconscious and vomited ± 2 times while in the ER. Primary survey results in the ER: a) Airway: patent; b) Breathing: normal; c) Circulation: acral warm, dry, red; c) Disability: GCS E1V1M1. Secondary survey results in the ER: Blood pressure: 120/70 mmHg, Pulse: 82 x/min, Respiratory Rate: 22 x/min, Temperature: 36.4 ℃, SpO2: 98%, LLA: 27 cm (normal). The patient had a medical diagnosis: severe brain injury, GCS E1V1M1, and Intracerebral Hemorrhage (ICH).

Traumatic Intervention

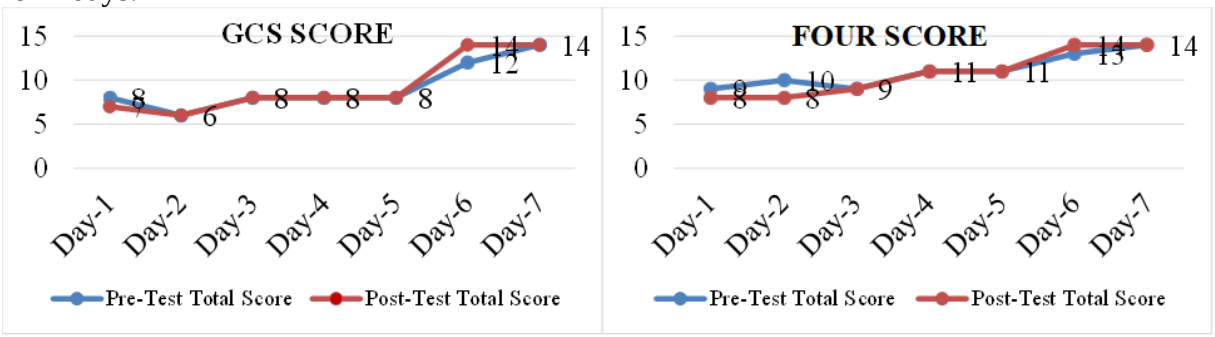
The initial assessment by researchers was carried out on March 28th, 2024 at 08.00 a.m. on the patient, Mr. R, with severe brain injury and ICH on day 1; the patient had stable hemodynamics, decreased consciousness GCS E2V2M4, collar neck was attached, there was a wound dressing ± 10 cm long in the right frontoparietal region, a dower catheter is installed with a urine output of 50 cc, an NGT is installed with a D5 diet 6x50 cc/day, installed O2 NRBM therapy 10 lpm, and head up 30^{o}. According to the Pedoman Nasional Pelayanan Kedokteran Tatalaksana Cedera Otak Traumatik (2022) article, a neck collar stabilizes the cervical spine and provides bed rest with a head-up of 30^0 as a general nonsurgical treatment. Furthermore, patients with decreased consciousness also require the installation of an NGT to

facilitate fluid and nutritional intake (Pedoman Nasional Pelayanan Kedokteran Tatalaksana Cedera Otak Traumatik, 2022). Medical therapy of citicolin 2x500 mg and piracetam 3x2 gr was stopped, and nimodipine injection therapy (10 mg/24 hours/IV) was added.

The patient was transferred to Asparaga Room on April 02, 2023. The patient received Asering IVFD treatment therapy 1000 cc/24 hours; ceftizoxim injection 2x1 g, phenytoin 3x100 mg, antrain 3x1 g, ranitidine 2x50 mg, ondansetron 3x4 mg; oral nimodipine 6x60 mg.

Follow-up and Outcomes

After 7 days of family-centered auditory and tactile sensory stimulation, the level of consciousness measured by GCS increased. Furthermore, Figure 1a shows that the GCS measurement results on the first day before implementation were GCS E2V2M4 (Stupor) and on 7 days after implementation GCS E3V5M6 (Alert). This shows that there was an increase in the GCS score of Mr.R after simultaneous auditory and tactile sensory stimulation therapy for 7 days.



(1a) (1b)

Figure 1. Results of Auditory and Tactile Sensory Stimulation on GCS Scores and FOUR Score

Figure 1b shows that the FOUR score on the first day before implementation was E1M2B4R2, and on the 7th day after implementation, it was E2M4B4R4. This shows an increase in the FOUR Score for Mr.R after simultaneous auditory and tactile sensory stimulation therapy for 7 days.

DISCUSSION

Effectiveness of Auditory and Tactile Sensory Stimulation in Identifying Changes in Level of Consciousness Patients with TBI

The results revealed no increase in FOUR and GCS scores before and after auditory and tactile sensory stimulation on day 1. Still, there was an increase in FOUR and GCS scores on the 7 days after simultaneous implementation. This agrees with research (Ahmed et al., 2023), that staying in the ICU for a long time can cause sensory disturbances, which can impact the recovery of the central nervous system. The study results showed that organized family-centered stimulation, especially auditory and tactile stimulation, could increase the patient's awareness and physiological stability and significantly help the recovery of TBI patients on the 14th day. In line with research (Ahmed et al., 2023), sensory stimulation provided by family members to patients treated in the ICU can significantly reduce the incidence and duration of delirium in TBI patients. This is caused by a lack of balance in sensory stimulation in ICU patients, thereby leading to cognitive dysfunction and impaired consciousness. Providing sensory stimuli can improve nerve function and prevent delirium.

In another study conducted by (Hoseini et al., 2022), there was a significant increase in the intervention group on the third day and the following day after providing auditory sensory stimulation in the form of family members' voices combined with instrumental music on the

patient's awareness and cognitive function. In line with research by (Varghese et al., 2021), comatose patients who were treated in the ICU and received familiar sound stimulation via MP3 got a total GCS score 15 times faster than the control group. Furthermore, the intensity threshold for auditory stimulation is 10 Hz (Cavinato et al., 2015). In addition, significant changes in behavioral responses, such as facial expressions and limb movements, after receiving auditory stimulation (Varghese et al., 2021). Thus, auditory stimulation provided by the voices of people nearby can increase the awareness of TBI patients.

Foot massage and tactile stimulation of the wrist can increase blood flow and brain oxygenation, thereby increasing awareness among TBI patients (Salehi et al., 2019)**.** Tactile stimulation of the wrist can significantly reduce systolic blood pressure, pulse rate and respiratory rate compared to not touching the wrist (Salehi et al., 2019)**.** Supported by research by (Sedghi & Ghaljeh, 2020), tactile stimulation of the wrist to fingers can increase consciousness and reduce agitation in comatose patients. According to Cavinato et al. (2015) the study, stimulation of the median nerve located at the wrist shows a response from the primary motor cortex (N20), thereby generating somatosensory activity. The somatosensory system functions in the periphery as sensory receptors (thermoreceptors, mechanoreceptors, etc.) to detect various stimuli; in the spinal cord, it functions to convey information from the periphery and throughout the body to the brain, in the brain, the postcentral gyrus contains Brodmann's areas (BA) 3a, 3b, 1, and 2 which form the somatosensory cortex for processing the body's sensors (Guy-Evans, 2020). Thus, tactile stimulation given to the wrist area will stimulate increased brain activity and information processing (Cavinato et al., 2015).

According to the theory of Hudak and Gallo (2002) in (Lumbantobing & Anna, 2015), patients with moderate brain injury have a better prognosis compared to patients with severe head injury. Severe head injury has a worse prognosis because it often experiences systemic hypoxia (Lumbantobing & Anna, 2015). This is because head injury patients will experience a 50% decrease in blood flow at the beginning of the injury phase, but cerebral blood flow will increase within 48 and 72 hours (Sari et al., 2023). Therefore, patients should be given auditory and tactile sensory stimulation therapy immediately.Sensory stimulation can be unimodal or multimodal, but the study (Norwood et al., 2023), shows that multimodal stimulation is considered more effective. Multimodal refers to the simultaneous application of more than one stimulus at a certain time simultaneously. Furthermore, (Norwood et al., 2023) it demonstrated that multimodal stimulation mode is more effective in increasing the level of consciousness when compared to unimodal. Providing sensory stimulation needs to pay attention to "by whom" and "how" the intervention is given because close people such as family members are more effective because they influence the feelings, hopes and perceptions of patients being treated in the ICU. In this study, the family used auditory and tactile sensory stimulation to increase the awareness level of injured patients.

Effectiveness of FOUR and GCS Scores as Measuring Tools for TBI Patients' Level of Awareness

In this study, the FOUR and GCS scores could measure the patient's level of consciousness well. Still, the FOUR score was considered superior because the patient had right eyelid edema, making measuring the eye's response a little difficult. The FOUR score does not measure eye response but rather measures brain stem reflexes and breathing. This research is in line with (Abdallah et al., 2020), showing that the results of the FOUR and GCS scores are effective in predicting death within 30 days; the FOUR scores can help early identification of brain problems, help triage and management, and identify brain herniation and respiratory issues. The FOUR score is considered to help differentiate patients who require ICU care or

high monitoring units (HMU). In addition, the FOUR score is useful for intubated patients because it can predict mortality better than GCS. Supported by research by (Özçelik & Celik, 2021), the GCS and FOUR scores are valuable instruments for neurological assessment in patients in the ICU, with the FOUR score potentially being easier to use and detailed, especially for less experienced healthcare providers.

In another study conducted by (Suresh et al., 2019), a comparative study was carried out on the use of GCS and FOUR scores in various patient groups, such as medical, surgical, and trauma cases with varying levels of observer experience. The FOUR Score is considered to have added value because it can evaluate brain stem reflexes and breathing patterns, which can complement the assessment of the GCS score of comatose patients. Although the FOUR score provides more neurological details than the GCS, the GCS remains the standard coma scale in the ICU because it has gone through a long validation process. In line with research by (Agrawal et al., 2023), the GCS score shows the best correlation in TBI patients compared to the FOUR scores. Another study by (Javvaji et al., 2022), showed that the FOUR and GCS scores were comparable in predicting patient death. However, the superiority of one score over another cannot be determined with certainty due to overlapping confidence intervals. Thus, using the FOUR and GCS scores have comparable abilities in predicting the prognosis of TBI patients, but the GCS score has been used longer than the FOUR score, so it is considered more reliable.

Mechanism of Auditory and Tactile Sensory Stimulation on Level of Consciousness

Auditory and tactile sensory stimulation will be provided by family members or people closest to you simultaneously. Then, the sound will move to the ear and be transmitted to the cochlea, which can separate the sound into different frequencies before converting the sound into electrical impulses (Augusta University, 2022). Then, neurons will carry electrical impulses from the cochlea to the brain's auditory cortex, namely the thalamus and amygdala (Augusta University, 2022). The thalamus and amygdala are parts of the brain that regulate emotions or behavior so that the brain remains awake. This mechanism allows sensory stimulation to reach the brain stem and cortex to be activated despite injury because the auditory system is the last sense that can function properly (Septiany et al., 2019).Providing auditory sensory stimuli can activate the Reticular Activating System (RAS) and the middle part of the brain (Eli et al., 2021; Septiany et al., 2019). Physiologically, patient consciousness requires ongoing interaction between the cerebral hemispheres and the reticular formation in the brain stem. When a stimulus stimulates the reticular formation, the resulting impulse will be sent to the RAS to increase RAS activity. These changes will stimulate the cerebral cortex, resulting in increased excitation and level of consciousness (Septiany et al., 2019).

Tactile stimulation provided in the first 72 hours after an injury event is essential for the patient's recovery, quality of life, and long-term prognosis (YekeFallah et al., 2018). Tactile stimulation can increase cognitive processes, stimulate the sympathetic nervous system, and improve mood. Tactile stimulation affects the reticular activation system, resulting in increased sympathetic nerve activity by releasing norepinephrine and activating the nervous system, stimulating brain development and increasing the level of consciousness (Eli et al., 2021). So far, there have been no indications of harm from the tactile stimulation program to increase patient awareness. According to Sedghi & Ghaljeh (2020), the tactile stimulation method is considered safe, effective, practical, and simple for eliminating patient anxiety and reducing pain and patient anxiety without dangerous side effects.

This study analyzes the effectiveness of auditory and tactile stimulation therapy in patients with traumatic brain injury on day 1 in the ICU at a public hospital. The variable analyzed by researchers is the level of awareness using the GCS and FOUR Score measuring instruments. While undergoing treatment in the ICU until April 01st, 2024, he received antrain therapy 3x 1gr and in the Asparaga Room on April 2nd-03rd, 2024. antrain is an analgesic drug that relieves pain by suppressing the central nervous system. The drug is a confounder of the patient's level of consciousness. antrain injection is given every 02.00 p.m., 10.00 p.m., and 06.00 a.m. Solving problems, researchers carry out implementation and evaluation every day between 04.00 p.m. and 06.00 p.m.

CONCLUSION

The conclusions from this research are: There was an increase in GCS scores after 7 days of simultaneous implementation, with a total initial GCS score of 8 (stupor) to 14 (alert); there was an increase in the FOUR scores after implementing it for 7 days simultaneously, with the initial score being E1M2B4R2 and the 7th day after implementation being E2M4B4R4; and auditory and tactile sensory stimulation therapy is an effective alternative to pharmacological therapy in the ICU to increase awareness of TBI patients. Furthermore, measuring the level of consciousness using the FOUR Score is considered superior to GCS because it can measure the brain stem response in Mr. R, who experienced palpebral edema.

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