



EFFECT OF MATERNAL VOICE RECORDINGS ON CONSCIOUSNESS IN MECHANICALLY VENTILATED CHILDREN IN THE PICU

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ABSTRACT

The Pediatric Intensive Care Unit (PICU) has limitations on family visitation, resulting in family-centered care not being optimally implemented. Meanwhile, pediatric patients who are mechanically ventilated in the PICU often experience decreased levels of consciousness due to sedation. One effort to maintain the emotional bond between mothers and their children and to improve the level of consciousness is through exposure to recorded maternal voices. This study aimed to evaluate the effect of maternal voice recordings on the level of consciousness of ventilated pediatric patients. This study used a quasi-experimental pretest–posttest design with a control group. A non-probability sampling technique with a consecutive sampling approach was applied. A total of 34 respondents were recruited, consisting of 17 participants in the intervention group and 17 in the control group. The intervention consisted of listening to maternal voice recordings, while the control group was exposed to non-maternal voice recordings. Data were collected through observation using the FOUR score. The data were analyzed using an independent t-test, and the results demonstrated that exposure to maternal voice recordings significantly improved the level of consciousness compared to non-maternal voice recordings. Maternal voice recordings can be considered a non-pharmacological intervention to enhance the level of consciousness in mechanically ventilated pediatric patients under sedation.

Keywords: maternal voice; mechanical ventilation; pediatric patients; PICU; unconscious

How to Cite (in APA Style)

Septika, R., Fatmawati, F., Julita, E., Ammelda, R., Fitri, R., & Reswari, W. (2026). Effect of Maternal Voice Recordings on Consciousness in Mechanically Ventilated Children in the PICU. *Indonesian Journal of Global Health Research*, 8(2), 583–588. <https://doi.org/10.37287/ijghr.v8i2.1589>.

INTRODUCTION

The Pediatric Intensive Care Unit (PICU) is a specialized unit that delivers intensive monitoring and care for pediatric patients with life-threatening critical conditions (IDAI, 2016). Pediatric patients admitted to the Pediatric Intensive Care Unit (PICU) represent a highly vulnerable population with a high risk of developing neurological impairment. Neurological dysfunction may occur as a result of the primary disease process or secondary complications related to critical illness, including hypoxia, systemic inflammation, hemodynamic instability, and invasive medical interventions such as mechanical ventilation and sedation. Altered levels of consciousness and neurological injury are frequently observed among critically ill children and are associated with increased morbidity, prolonged mechanical ventilation, and extended length of stay in the PICU (Holmes and Bracken, 2022; Choong, et al., 2024).

The Pediatric Intensive Care Unit (PICU) commonly enforces restrictive family visitation policies, limiting parents' ability to remain physically present with their hospitalized children. This condition restricts the optimal implementation of family-centered care (FCC), despite evidence demonstrating that parental involvement plays a crucial role in supporting pediatric recovery (Pineda et al., 2020). Nurses have a pivotal role in facilitating parent–child closeness, one of which is through non-pharmacological interventions such as the provision of maternal voice recordings (Ullattil et al., 2021). Exposure to the maternal voice has been shown to influence emotional regulation and brain functional development in children (Smith et al., 2020), as well as to modulate neurological responses by activating limbic pathways and enhancing emotional engagement. These mechanisms

may contribute to improvements in the level of consciousness among critically ill pediatric patients (Brown & Jones, 2019; Williams et al., 2021). Overall, maternal voice-based interventions are non-invasive, easy to implement, and effective in enhancing children's socio-emotional functioning (Davis, 2018; Miller et al., 2022), which is consistent with the principles of family-centered care in pediatric nursing.

This study was conducted at Dr. M. Djamil General Hospital Padang, a tertiary referral center for critically ill pediatric patients in West Sumatra Province, Indonesia. As a teaching hospital and a level III healthcare facility, Dr. M. Djamil General Hospital Padang manages a high volume of pediatric patients requiring mechanical ventilation, with patient characteristics that are representative of the regional referral population. In addition, the hospital has the capacity to implement maternal voice recording interventions and to evaluate the effectiveness of these interventions on patients' level of consciousness using the FOUR Score, a tool specifically designed to assess consciousness in intubated patients who are unable to provide verbal responses. The findings of this study are expected to contribute valuable evidence to support the development and implementation of non-pharmacological nursing interventions for critically ill pediatric patients in Indonesia.

METHOD

This study employed a quasi-experimental design using a pretest–posttest non-equivalent control group approach to analyze the effect of recorded maternal voice exposure on the level of consciousness of mechanically ventilated pediatric patients in the Pediatric Intensive Care Unit (PICU) of Dr. M. Djamil General Hospital Padang, Indonesia, conducted from January to August 2025. The study population consisted of all pediatric patients receiving mechanical ventilation in the PICU. A non-probability sampling method with a consecutive sampling approach was applied. A total of 34 respondents were recruited, with 17 assigned to the intervention group and 17 to the control group. Inclusion criteria were children aged 2–12 years, a Glasgow Coma Scale (GCS) score ≤ 12 , hemodynamically stable condition, and the use of sedative and/or analgesic medications. Exclusion criteria included documented hearing impairment, congenital anomalies or developmental delay, and terminal illness.

The study instruments consisted of a respondent characteristics questionnaire and the FOUR Score to assess the level of consciousness. The Four score shows good predictive validity for mortality and neurological outcomes in critically ill patients and internal consistency has been reported with Cronbach's alpha values ranging from 0.86 to 0.90 across different clinical populations (Iyer et al., 2009; Stead et al., 2009). Participants in the intervention group were exposed to recorded maternal voices, while those in the control group received non-maternal voice recordings. Each recording lasted 30 minutes and was delivered through headphones at a sound intensity of 50–60 dB. The intervention was administered three times daily (at 10:00, 16:00, and 22:00) for two consecutive days. Assessment of the level of consciousness was conducted one day prior to the intervention and repeated after completion of the intervention on day 3. Data were analyzed using an independent t-test.

RESULT

Based on respondent characteristics, female patients predominated in both groups, with 42.94% in the maternal voice group and 58.83% in the non-maternal voice group. Regarding age distribution, the majority of participants in the maternal voice group were aged 2–3 years (78.48%), whereas in the non-maternal voice group most participants were aged 4–6 years (52.94%). The length of hospital stay was predominantly 1–3 days in both groups, accounting for 76.48% in the maternal voice group and 64.70% in the non-maternal voice group.

Table 1.
Comparison of Levels of Consciousness in Mechanically Ventilated Pediatric Patients Following Exposure to Maternal and Non-Maternal Voice Recordings

Group	n	Pre Intervention (Mean $\pm$ SD)	Post Intervention (Mean $\pm$ SD)	Δ mean $\pm$ SD	P Value
Intervention (Maternal voice)	17	7,88 $\pm$ 1,29	10,82 $\pm$ 1,63	2,94 $\pm$ 1,20	<0,001*
Control (Non- maternal voice)	17	8,35 $\pm$ 1,99	8,53 $\pm$ 1,96	0,18 $\pm$ 0,39	0,083

*Significant at $p < 0.05$.

Table 1 shows a significant increase in scores in the intervention group from 7.88 ± 1.29 to 10.82 ± 1.63 after the intervention, with an average difference (Δ mean) of 2.94 ± 1.20 . Statistical tests indicate that this increase is statistically significant ($p < 0.001$). Meanwhile, in the control group, the average score before the intervention was 8.35 ± 1.99 , which slightly increased to 8.53 ± 1.96 , with an average difference of only 0.18 ± 0.39 , and statistically, it did not show a significant difference ($p = 0.083$). These results indicate that the intervention had a significant effect on score improvement, whereas there was no meaningful change in the control group.

Table 2.
Comparison of Consciousness Level Improvement Between Intervention and Control Groups

Group	n	Post Intervention (Mean $\pm$ SD)	Δ Mean (Post-pre)	t	P Value
Intervention (Maternal voice)	17	10,82 $\pm$ 1,63	2,94	3,40	0,002*
Control (Non-maternal voice)	17	8,35 $\pm$ 1,99	0,18		

*Independent t-test; $p < 0.05$ indicates statistical significance.

As presented in Table 2, a statistically significant difference was observed in the improvement of consciousness levels between the intervention and control groups. Children exposed to recorded maternal voices demonstrated a significantly higher post-intervention FOUR Score (mean $\pm$ SD: 10.82 ± 1.63) with a mean increase of 2.94 points compared to baseline. In contrast, the control group exposed to non-maternal voice recordings showed only a minimal improvement (Δ mean = 0.18). Independent t-test analysis confirmed that the improvement in the intervention group was significantly greater than that in the control group ($t = 3.40$; $p = 0.002$).

DISCUSSION

In this study, the majority of participants in both groups were female. Previous research by Zhang et al. (2020) demonstrated that females show greater activation in brain regions related to empathy and attention when exposed to infant vocal stimuli compared with males. This sex-related difference may partially explain the favorable response to maternal voice recordings observed in this study. Biological and psychosocial factors associated with sex may influence responsiveness to auditory-based interventions, particularly emotionally meaningful stimuli such as the mother's voice, thereby potentially enhancing the effectiveness of maternal voice exposure on the level of consciousness in critically ill children.

Regarding age distribution, younger children—particularly those aged 2–3 years—were more prevalent in the maternal voice group. Recent studies emphasize that early childhood is a sensitive period for auditory and emotional processing, during which familiar voices, especially parental voices, play a crucial role in modulating attention, emotional regulation, and neural responsiveness (Di Stefano et al., 2022; Lordier et al., 2023). Higher neural plasticity and stronger attachment-related responses in younger children may enhance sensitivity to emotionally meaningful auditory stimuli, thereby increasing the effectiveness of maternal voice exposure in improving levels of consciousness. In the control group, the majority of participants were aged 4–6 years and were exposed to non-maternal voice recordings. Children in this age range are typically in a more advanced stage of cognitive and emotional development, characterized by increasing autonomy and reduced dependence on primary attachment figures for emotional regulation. As a result, auditory

stimuli that lack strong emotional relevance, such as non-maternal voices, may elicit weaker arousal and attentional responses in this age group.

Previous studies have shown that preschool-aged children possess more mature auditory perceptual and cognitive processing abilities, enabling them to differentiate between familiar and unfamiliar sounds more efficiently. However, this developmental advancement may also reduce the emotional salience of unfamiliar auditory stimuli, limiting their impact on arousal and consciousness levels (Vilela, 2020; Cheng et al., 2018). Consequently, exposure to non-maternal voice recordings may provide general auditory stimulation but fail to trigger the emotional and limbic activation necessary to produce meaningful improvements in consciousness.

Moreover, the age-related distribution of respondents further strengthens these findings. Children aged 2–3 years in the intervention group demonstrated greater responsiveness to maternal voice stimulation, highlighting the importance of early attachment bonds in activating limbic and cortical pathways associated with consciousness. Meanwhile, children aged 4–6 years in the control group exhibited limited response to non-maternal voices, likely due to their increasing cognitive independence and reduced emotional dependency on caregivers.

The majority of respondents had a length of stay of 1–3 days, indicating that most children were in the acute phase of intensive care. This finding underscores the critical importance of early, consistent, and continuous auditory stimulation, particularly during the initial days of PICU admission, to optimize neurological responsiveness in mechanically ventilated children. Early exposure to meaningful sensory input is known to support arousal regulation and prevent sensory deprivation during critical illness (Harrison et al., 2022).

During this early adaptation period, exposure to the mother's voice provides emotional familiarity and a sense of security, which may attenuate stress responses and support stabilization of consciousness. The maternal voice has been shown to exert a unique calming effect, reduce stress-related physiological responses, and shape neural processing related to language and emotional regulation (Dewar, 2021; Filippa et al., 2020). Therefore, integrating maternal voice recordings early in the course of intensive care represents a feasible, safe, and clinically relevant nursing intervention to support recovery of consciousness and promote holistic pediatric critical care.

The findings of this study indicate that maternal voice recordings significantly increase patients' levels of consciousness compared with non-maternal voice recordings. The improvement observed in the maternal voice group was markedly greater and statistically significant ($p < 0.001$), whereas no significant change was found in the non-maternal voice group. These results are consistent with previous studies showing that auditory stimulation using the mother's voice enhances consciousness and physiological stability in critically ill pediatric patients (Attia Tolba et al., 2023). In addition, repeated exposure to the maternal voice has been shown to promote neuroplasticity by stimulating auditory cortical development, further supporting its role in improving arousal and neurological responsiveness (Pocwierz-Marciniak et al., 2021).

Maternal voice recordings significantly improve levels of consciousness in mechanically ventilated pediatric patients compared with non-maternal auditory stimulation. This intervention is simple, safe, and non-invasive, and it leverages emotional familiarity to enhance neurological responsiveness during critical illness. Incorporating maternal voice stimulation into routine PICU nursing care may support early recovery of consciousness and promote family-centered, developmentally appropriate care.

Physiologically, familiar voices—particularly those from emotionally significant figures such as the mother—are able to stimulate activity within the limbic system and cortical brain areas associated with attention and consciousness. Familiar and emotionally salient auditory stimuli have been shown to activate neural networks involved in arousal regulation and emotional processing,

including the amygdala and anterior cingulate cortex (Filippa et al., 2020; Zhang et al., 2020). In addition, the emotional bond between mother and child can amplify the effects of auditory stimulation. This mechanism aligns with attachment bonding theory, which posits that the maternal voice represents one of the earliest and most powerful forms of communication and remains deeply encoded across the lifespan (Bowlby, 2019; Bernier & Meins, 2021). Accordingly, the findings of this study indicate that maternal voice stimulation has a significantly greater impact on enhancing consciousness in comatose children compared with non-maternal auditory stimuli. This effect may be attributed to the strong emotional salience and measurable neurophysiological influence of the mother's voice on children's levels of consciousness, even in the presence of ongoing sedative therapy (Attia Tolba et al., 2023).

This effect may be attributed to a calmer physiological state in which cortical activity becomes more optimally regulated, thereby facilitating improvements in the child's level of consciousness. In contrast, non-maternal voices function as emotionally neutral stimuli and lack the capacity to activate emotional memory pathways, making them less effective in enhancing consciousness in sedated children¹. Although sedation pharmacologically suppresses cortical activity and may reduce responsiveness to external stimuli, evidence suggests that highly emotionally salient inputs—such as the mother's voice—can still be processed under light to moderate sedation. This supports the finding that personally meaningful auditory stimuli are capable of partially overcoming sedation-induced depression of consciousness

CONCLUSION

Maternal voice recordings significantly improve consciousness in mechanically ventilated and sedated pediatric patients. This simple, safe, and low-cost non-pharmacological intervention provides emotional comfort and a sense of security, simulating the presence of the mother during PICU care. Clinically, these findings highlight the importance of family-centered care and structured sensory stimulation protocols. PICU units should integrate maternal voice recordings into routine nursing practice, with consistent scheduling and documentation in the Integrated Patient Progress Notes (IPPN), to support recovery of consciousness and promote holistic pediatric critical care.

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