

Effect of Family Multisensory Stimulation on the Occurrence of Delirium among Mechanically Ventilated Patients

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Abstract

Multisensory stimulation is a key element of non-pharmacological treatments for prevention and management of delirium. It offers a setting that is similar to the actual world and stimulates conscious mechanically ventilated patients in a safe and controlled manner. **Aim:** - evaluate the effect of family multisensory stimulation on the occurrence of delirium among mechanically ventilated patients. **Design:** - A quasi experimental research design was utilized. **Setting:** this study was conducted at Surgical Intensive Care Unit of Emergency Tanta University Hospital, Egypt. Convenience sampling of 80 adult conscious mechanically ventilated patients was selected and divided equally into two groups; 30 patients in each. **Tools of the study:** Three tools were used: Mechanically Ventilated Patients' Assessment Tool, Delirium Assessment Tool, and Family Satisfaction Questionnaire Assessment Tool. **Results:** the current study results indicated that the intervention group showed significant reductions in delirium incidence (20.00% & 16.66%) than the control group (50.00% and 60.0%) during the fifth and seventh day, respectively. Additionally, highly statistically significant differences were found between the two groups regarding family satisfaction level during the fifth day and the seventh day with $p=0.001$ and 0.000 , respectively. **In conclusion,** family multi-sensory stimulation proved to be an efficient non-pharmacological intervention for decreasing the occurrence of delirium and increasing family's satisfaction. **Recommendations,** the current study recommends integrating multisensory stimulation in nursing care of mechanically ventilated patients to prevent delirium and suggests replication of the study with a larger sample.

Keywords: Delirium, Mechanically Ventilated Patients, & Multisensory Stimulation.

Introduction:

In the Intensive Care Unit (ICU), the percentage of patients needing mechanical ventilation varies between 39 % and 74 % in the Intensive Care Unit (ICU) (Johnson, Towell-Barnard, McLean, & Ewens, 2024). The focus of care for mechanically ventilated patients has been on managing their illness (Wu, Chang, Tranyor, & Chiu, 2024).

Delirium occurs in about 20-50% of critically ill patients and in about 50- 80% of patients receiving mechanical ventilation for >72 hours. It frequently arises within a brief timeframe, ranging from hours to days, and fluctuates over time (Möllmann et al., 2025).

Delirium is a neurocognitive disorder, that is marked by an acute and reversible disruption of attention, awareness, and cognition. It is a

common postoperative complication in the ICU, often occurs due to acute illness, trauma, pain, or toxins (Dutta et al., 2022). Delirium is linked to negative outcomes including functional disability, cognitive impairment, nosocomial pneumonia, bed falls, self-extubation, and prolonged mechanical ventilation that increase ICU lengths of stay and mortality (Bisson et al., 2024).

Delirium presents a costly and serious health problem. However, it is under-recognized by the health care team. Factors that increase the risk of delirium include being elderly, experiencing cognitive decline before admission, having visual or hearing impairments, abusing alcohol, and prior use of benzodiazepines (Ye, Ho, & Lee, 2024).

Additionally, the utilization of catheters, unaddressed pain, psychoactive drugs, lack of

sleep, severe sepsis, hypoxemia, dehydration, low blood pressure, biochemical irregularities, and anemia are considered precipitating factors (**Bayramzadeh, Ahmadpour, & Aghaei, 2021**).

Multisensory stimulation is non-pharmacological interventions including a diversity of activities such as consciousness, visual, auditory, olfactory, and tactile stimulation (**He et al., 2024**). It aims at increasing concentration and attention, promoting positive memories, enhancing cognitive functions, improving communication, improving sensory integration, reducing anxiety, and increasing overall well-being (**Deemer et al, 2020**).

Researches proved that sensory stimulation implemented by family members has better positive effects for the patient. It can promote defense mechanism and stress resistance of the patients and is strongly important in the prevention of delirium. Moreover, family members can easily detect changes in patients' behavior, awareness and cognition as they are more familiar with the patient's behavior (**Li et al., 2025; Pinto, Dores, Geraldo, Peixoto, & Barbosa, 2020**).

Auditory stimuli such as the voices of the family members can establish a comfortable setting and offer personal care in a manner that nurses cannot. Also, it serves as constructive distractions and helps controlling agitated patients (**Attwell et al., 2019**).

Visual stimuli like family members' photos and familiar visuals can improve cognitive performance and control the circadian cycle. The scent of flowers and spices are examples of olfactory stimuli that can help with memory recall. The warmth of a mug is one example of a tactile stimulus that might elicit pleasant feelings and memories (**Zuo et al., 2021**).

The goals of nursing care for patients with delirium are to determine the underlying reasons, minimize possible triggers, and use non-pharmacological therapies to lessen agitation and increase comfort. Early delirium

detection, assessment, and management through coordinated multidisciplinary actions are critical tasks for critical care nurses (**Wang et al., 2021**).

Critical care nurses should be aware for indicators and manifestations of delirium, including shifts in cognition, orientation, and consciousness. Critical care nurses should interact with patients and their families in a soothing and calm manner. Incorporating family members into caregiving can ease anxiety and offer emotional support (**Meghani & Timmins, 2024**).

Significance of the study

Despite broad efforts and advances in developing delirium prevention interventions, the incidence of delirium remains high in Egyptian hospitalized patients (**Abd-Elghaffar, El-Senousy, & Mourad, 2024**). Delirium is linked to longer duration of mechanical ventilation, longer hospital stays, worsening cognitive and functional deterioration, greater readmission rates, raises medical expenses, and has negative impacts patients' families. The incidence and prevalence of delirium in Tanta University Hospitals is not well established which may be due to low rates of reporting and detection. Additionally, there is no regular screening of delirium using reliable and valid assessments tools.

Many studies focus on nonpharmacologic treatment of delirium in Egypt such as delirium prevention bundle, sleep promotion, early mobility. (**Elcokany & Ahmed, 2019**). Multisensory stimulation integrates several senses at the same time to enrich sensory experiences and possibly enhance cognitive and emotional health. This method aids mechanically ventilated patients in linking to their surroundings and handling behavioral symptoms. Therefore, this study is critically needed to evaluate the effect of family multisensory stimulation on the occurrence of delirium among mechanically ventilated patients.

Aim of the Study:

The aim of the study was to evaluate the effect of family multisensory stimulation on the occurrence of delirium among mechanically ventilated patients.

Research hypothesis:

- 1) Mechanically ventilated patients who receive family multisensory stimulation are expected to have reductions in incidence, severity and adverse events of delirium and decreasing duration of mechanical ventilation and length of ICU stay than control group.
- 2) Families of mechanically ventilated patients' who implement multisensory stimulation are expected to have high satisfaction levels than families of the control group.

Subjects and Methods

Research design: A quasi experimental research design was utilized. This design is a two group design which examines the effect of one or more independent variables on the dependent variables with no or slight randomization (Maciejewski, 2020).

Setting:

This study was conducted at Surgical Intensive Care Unit of Emergency Tanta University Hospital which is affiliated to Ministry of Higher Education and Scientific Research. It consisted of three rooms with the capacity of fifteen beds.

Subjects:

A convenience sampling of 60 adult mechanically ventilated patients who fulfilled the inclusion criteria was selected from the previously mentioned setting. The sample size was estimated using Epi Info 7 Statistical Program, and the total conscious mechanically ventilated patients admitted per year according to review of Tanta University Hospital statistical health record in 2024 were 100 patients and the sample size calculated as the following:

- Total patients are 100 per year
- Confidence level=99.9%
- Expected frequency=50%
- Accepted error=5%
- Confidence coefficient=95%

The sample was divided into two equal groups, 30 patients in each as the following:

Control group: received routine ICU care that was implemented by the ICU nursing staff for prevention of delirium such as permitting families to spend a brief and restricted amount of time with their patients.

Study group: received multisensory stimulation that was implemented by the family under supervision of the researchers in addition to the routine ICU care.

Inclusion criteria include:

- Adult patients aged 21 years and above of both sex.
- Newly admitted patients receiving mechanical ventilation for >24 hours.
- Glasgow Coma Scale score greater than 9, with Richmond Agitation-Sedation Scale (RASS) score ≥ -3 on admission.
- Patients free from delirium on admission.
- Patients having family member who was at least eighteen years old and provided informed consent to take part in the study

Exclusion criteria include:

- Severe visual and/ or hearing impairment.
- Loss of skin integrity in the areas of therapeutic touch.

Tools of data collection

Three tools were used to collect data which included:

Tool I: Mechanically Ventilated Patients' Assessment Tool

This tool was developed by the researcher after extensive review of recent relevant literature (Mosharaf, Alam, Gow, & Mahumud, 2025; Wang, Lu, Chen, & Wu, 2024) and it

consisted of four parts as the following:

- **Part a: Patients' Socio-demographic Data:** it included patients' code, age, gender, most significant family member, and number of visitors.
- **Part b: Clinical data:** it included current diagnosis, past medical history, duration of mechanical ventilation, and length of ICU stay.
- **Part c: Glasgow Coma Scale:** Glasgow Coma Scale (GCS) was developed by **Teasdale and Jennett (1974)** to assess the level of consciousness. This scale has three graded items: verbal response from 1 to 5, physical response from 1 to 6, and eye opening from 1 to 4.

Scoring system

- GCS score 13-15: patients were awaked, could present with confusion but were able to follow directions and to communicate.
- GCS 9-12: patients were typically drowsy or obtunded; they could opened eyes and localized painful stimuli upon assessment.
- GCS 3-8: patients presented as obtunded to comatose, they were unable to follow directions; & may exhibit decorticate or decelerate posturing.

Part d: Richmond Agitation Sedation Scale

This scale was developed by **Sessler et al., (2002)** to describe level of sedation or agitation in mechanically ventilated patients in order to avoid over and under-sedation. It consists of 10 categories; combative, very agitated, agitated, restlessness, alert and calm, drowsy, light sedation, moderate sedation, deep sedation, and unarousable.

Scoring System:

- Richmond Agitation Sedation Scale is a 10-point scale ranging from -5 to +4.
- Levels of sedation ranging from -1 to -5 (drowsy, light sedation, moderate sedation, deep sedation, unarousable)
- Levels of agitation from +1 to +4 (restless, agitated, very agitated, combative)

- RASS level 0 is "alert and calm."

Tool II: Delirium Assessment Tool

This tool was used to assess delirium incidence, severity, and adverse events. It consisted of three parts as the following:

Part (a): Confusion Assessment Method-Intensive Care Unit (CAM-ICU)

The confusion assessment method is a modification of **Inouye's (1990)** Confusion Assessment Method. It enabled delirium assessment at the bedside by non-psychiatrists. The CAM-ICU shows high inter-rater reliability ($\kappa=0.79-0.96$). Concurrent validation revealed sensitivities of 93-100% and specificities of 89-100%. Verbal communication is not necessary in the CAM-ICU. Therefore, individuals undergoing invasive mechanical ventilation may receive it. Four characteristics make up this tool: inattention, altered level of consciousness, acute alteration or fluctuating course of mental condition, and disorganized thinking.

Scoring system

Delirium is defined in terms of four diagnostic criteria (changes in mental status, inattention, the current level of consciousness, and disorganised thinking). The presence of traits 1 and 2 as well as either 3 or 4 is regarded as positive delirium.

Part (b): Confusion Assessment Method ICU-7 Severity of delirium (CAM-ICU 7):

It was developed by Khan et al., (2017). It is a rating scale with seven points which evaluated the severity of delirium and was based on the CAM-ICU's pre-existing components, but without the algorithm. Each component is assessed between 0 and 2.

Scoring system:

The CAM-ICU-7 score ranges from 0 to 7 points, the higher the score the more severe the delirium as the following:

- Score from 0 to 2 is classified as no delirium
- Score from 3 to 5 is classified as mild to moderate delirium
- Score from 6 to 7 is classified as severe delirium.

Part (c): Delirium adverse events

This part was developed by the researcher after comprehensive review of recent related literature (Schenning, Mahanna-Gabrielli, & Deiner, 2025; Liu et al., 2024) to assess the following adverse events: Removal of invasive lines, self-extubation, and physical injuries. The present adverse events scored 1 if the item is present or zero if the item is not present.

Tool III: Family Satisfaction Questionnaire

This tool was developed by the researchers after extensive review of recent relevant literature (Contreras et al., 2021; Rosa et al., 2019) to assess the family's satisfaction. It consisted of assessment of relationship with the staff, active role in the care, quality of care, nurse-family communication, and participation in decision-making. The family member chose one from 5-point Likert scale as follows: score 1= strongly disagree, score 2= disagree, score 3= undecided, score 4= agree, and score 5= strongly agree.

Scoring system:

- Low satisfaction level < 60%
- Moderate satisfaction level 60% -75%
- High satisfaction level > 75%

Method**Administrative process:**

The director of Emergency, Tanta University Hospital provided formal permission to conduct the study through official letters from the Faculty of Nursing outlining the goals of the current study. Data was gathered over a five-month period, beginning in early November and ending in April 2024.

Ethical consideration:

- Patients and their first class relatives gave their written informed consent following an explanation of the study's aim.
- Patients Privacy and data confidentiality were guaranteed to participants.
- The patient's right to remain anonymous and to withdraw from the study at any time was maintained.

- Scientific research ethical committee approval of the Faculty of Nursing Tanta University was obtained with the code number 545-10-2024.

Tools development:

Tool I part a and b, tool II part c, and tool III of this study were developed by the researchers after reviewing the relevant literature (Zhao et al., 2023; Yuyen et al., 2025) and used to collect the data.

Content Validity:

All tools were tested for content validity by seven expertises in the field of Critical Care and Emergency Nursing, Intensivists and Medical Biostatistics.

Reliability:

All tools of the study were tested for reliability using alpha Cronbach's test and found to be 0.896, 0.868, and 0.831 for the tool I, II, and III, respectively.

Pilot study:

It was carried out on 10% of the patients prior to the actual study in order to evaluate the various tool items' applicability, clarity, and feasibility. The current study did not include data from those patients.

Phases of data collection

The present study was conducted on four phases as the following

I. Assessment phase:

Patients' initial assessment within one hour of admission was performed for all studied patients using tool I to assess patients' socio-demographic characteristics, clinical data, and to determine patients who met the inclusion and exclusion criteria.

II. Planning Phase:

Planning phase was based on data from the assessment phase and expected outcomes criteria which was prescribed when planning patient care. It included:

- Decrease the incidence of delirium
- Decrease the severity of delirium
- Decrease the delirium adverse events

- Decrease the duration of mechanical ventilation
- Decrease the length of ICU stay
- Increase family's' satisfaction levels

During planning phase family members recorded videos and the researcher taught them the method of tactile stimulation.

The researcher developed scripts for the visual and auditory intervention components.

The script uses a simple language e.g. Hello! I'm (name of the speaker), you are now in intensive care unit, and the time is (current time). Nurses and doctors are looking after you 24 hours a day, the ICU is a bit noisy, but please try to relax. Do not touch the cables and tubes that are attached to your body. Because you are on a ventilator, you are unable to speak. I wish you a speedy recovery.

III. Implementation phase:

Control group: received routine ICU care implemented by the ICU nursing staff for prevention of delirium such as permitting families to spend a brief and restricted amount of time with their patients without any active family participation.

Study group: received family multisensory stimulation which was implemented by the family for seven days under supervision of the researchers in addition to the routine ICU care.

- Sensory stimulation was performed by the most significant family member that presented with the patient e.g. father, mother, sister, daughter, or brother.
- Sensory stimulation was taught to the family members by the researchers before the intervention. They were regularly checked and supervised by the researchers during the study.
- Sensory stimulation was developed by the researchers based on the comprehensive review of recent literature in this field (Xu et al., 2025; Şanlıtürk, Kaplan, & Dörtkardeş, 2023; Adineh, Elahi, Molavynejad, Jahani, & Savaie, 2023)

- During the stimulation process, the researchers delayed non-urgent nursing tasks and established a quiet atmosphere.
- Family visit for one hour/ day for the control group from 16:30–17:30. Family visiting hours for patients in the intervention group were 11:00–11:30, 16:00–16:30, and 10:00–10:30.

Family multisensory stimulation includes the following:

1. Consciousness stimulation:

- One time every hour, state the patient's name, the time, and the location close to their ears.

2. Visual stimulation

- Family members' video 2 minutes in length, every 2 hours.
- The patient was shown family members' photos and lovely images that caught patients' attention. Familiar photos and images were maintained in front of patient's eyes.

3. Auditory stimulation

- Patient's favorite family member's voice two minutes in length, every two hours.

4. Olfactory stimulation

- For ten seconds, the patient was exposed to scents and familiar odors which they were more used.

5. Tactile stimulation: therapeutic touch by a family member three sessions/ day each is about 15 minutes in length as the following:

- The family members were directed by the researcher to thoroughly wash their hands and rub them to warm them.
- The researcher instructed the family members to massage the patient from forehead to cheek to occipital bone without touching the endotracheal tube, and then massage the patient's forearm to upper arm on both arms without touching the peripheral venous catheter or central venous catheter.
- The researchers instructed the family members to massage the lower limbs and ankles without touching the femoral venous catheter or urinary catheter.

IV. Evaluation phase:

Evaluation was done for both intervention and control groups using tool II and tool III.

Evaluation was done on four times; immediately on admission, during the third, fifth and seventh day post-admission. Comparison was done between both groups to determine the effect of family multisensory stimulation on the occurrence of delirium among mechanically ventilated patients.

Results

Table 1: Socio demographic Characteristics: The results revealed that the mean age and standard deviation of the control group and study group were 48.70 ± 15.570 & 51.47 ± 17.395 years, respectively and 56.67% compared to 60.00 % the control group and study group were males, respectively.

Also, the results reported that each patient in both groups had more than one significant family member; however, daughters were the most significant family member with proportion of 30.00% of the control group and 33.33% of the study group. Additionally, an equal proportion (43.33%) of the control and the study groups had number of family visitors ranged from 3-< 5 members. No statistically significant differences were observed between the two groups regarding age, gender, most significant family members and the number of visitors with $p < 0.05$ for each.

Table 2: Patients' Clinical Data: Sub-arachnoid hemorrhage was the most prevalent diagnosis with proportion of 43.33% of the control group and the 36.67% of the study group. Moreover, diabetes mellitus was the most prevalent past medical history with proportion of 40.00% of the control group and the 46.67% of the study group.

Figure 1: Compare duration of mechanical ventilation between the control group and the study group: The control group had significantly higher duration of mechanical ventilation 14.10 days versus 9.83 days of mechanical ventilation days in the study group. Additionally, length of ICU stay was significantly higher (19.2 days) in the control group compared to 12.87 days in the study group.

Table 3: Assessment of Glasgow Coma Scale (GCS) among the participants: The results presented that 36.67% of the control group compared to 33.33% of the study group had GCS score of 13-15 during the first day of ICU admission. While, 23.33% and 20.00% of the

control group compared to 43.33% and 50.00% of the study group had GCS score of 13-15 during the fifth and seventh day of ICU admission, respectively. Statistical significant differences were found between the two studied groups regarding GCS score during the third, fifth, and seventh day of ICU admission with $p < 0.05$ for each.

Table 4: Assessment of Richmond Agitation sedation Scale (RASS) among the participants: It was found that calm and cooperative category (category 0) of RASS scale was predominant category in the study group (50.00% and 53.33%) compared to 23.33% and 20.00% of the control group during the fifth and seventh day of ICU admission, respectively. However, no statistical significant differences were found between the two studied groups regarding RASS score during the third, fifth, and seventh day of ICU admission with $p > 0.05$ for each.

Table 5: Assessment of delirium among the participants: the results illustrated that 36.66% of the control group compared to 26.66% of the study group had delerium during the third followup day. Furthermore, during the fifth and seventh follow up days, 20.00% & 16.66% of the study group compared to 50.00% and 60.0% of the control group, had delerium, respectively. Statistically significant differences were found between the two groups regarding occurrence of delerium during the fifth and the seventh follow up days with $p = 0.001$ for each.

Regarding severity of delerium, the results illustrated that none of the study group compared to 13.33%, 23.33%, and 30.00% of the control group had severe delerium during the third, fifth, and seventh follow up days, respectively. Highly statistically significant differences were found between the two groups regarding severity of delerium during the fifth and the seventh follow up days with $p = 0.000$ for each.

Table 6: Assessment of family satisfaction level: Moderate satisfaction levels were recorded during the first day with an equal proportion (16.67%) in the control group and the study group. Moreover, an equal proportion (20.0%) of the control group compared to 33.33% and 43.33% of the study group had moderate level of satisfaction during the fifth and the seventh days. Highly statistically significant differences were found between the two groups regarding family satisfaction level during the fifth and the seventh

follow up days with $p = 0.001$ and 0.000 , respectively.

Table 7: Assessment of delirium adverse events among the participants: the p -values indicated statistically significant differences were found between the two groups regarding removal of invasive lines and physical injuries during the fifth and the seventh days with $p < 0.05$ for each. Additionally, statistically significant difference was found between the two groups regarding self extubation during the seventh day with $p = 0.004$.

Table 8: Relation between RAAS scale, GCS scale and occurrence of delirium throughout periods of implementation among the studied groups: This table concluded that statistical significant relations between GCS scale and the occurrence of delirium measured by CAM- ICU scale was found within the control group during the third follow up day with $p <$

0.05 . Also, statistical significant relations between RASS scale and the occurrence of delirium was found within the control group during the seventh follow up day with $p < 0.05$. While, no statistical significant relations between GCS, RASS scale and the occurrence of delirium were found within the study group during the third and seventh follow up days with $p > 0.05$.

Table (9): Effect of demographic characteristics of the studied groups on occurrence of delirium: This table represented that significant effect of age on the occurrence of delirium was found within the control group during the seventh follow up day with $p < 0.05$. Additionally, this table revealed that gender had no significant effects on the occurrence of delirium within the control group and the study group during the third and seventh follow up days with $p > 0.05$.

Table (1): Distribution of the studied critically ill patients regarding their socio-demographic characteristics.

Characteristics	The studied critically ill patients (n=60)				χ^2 P
	Control group (n=30)		Study group (n=30)		
	N	%	N	%	
Age (in years) ▪ (21-<30) ▪ (30-<40) ▪ (40-<50) ▪ (50-<60) ▪ (≥60)	6 3 4 9 8	20.00 10.00 13.33 30.00 26.67	5 4 3 11 7	16.67 13.33 10.00 36.67 23.33	0.645 0.958
Range Mean ± SD	(23-72) 48.70±15.570		(23-83) 51.47±17.395		t=0.649 P=0.519
Gender ▪ Male ▪ Female	17 13	56.67 43.33	18 12	60.00 40.00	FE 1.00
Most significant family member ▪ Husband ▪ Wife ▪ Daughter ▪ Son ▪ Sister ▪ Father ▪ Mother	6 2 9 6 6 5 7	20.00 6.67 30.00 20.00 20.00 16.67 23.33	6 1 10 7 4 4 6	20.00 3.33 33.33 23.33 13.33 13.33 20.00	0.627 0.731
Number of the visitors ▪ < 3 ▪ (3-< 5) ▪ ≥ 5	8 13 9	26.67 43.33 30.00	7 13 10	23.33 43.33 23.33	0.628 0.730

FE: Fisher' Exact test

Table (2): Distribution of the studied critically ill patients regarding their clinical data

Clinical data	The studied critically ill patients (n=60)				χ^2 P
	Control group (n=30)		Study group (n=30)		
	N	%	N	%	
Diagnosis					
▪ Subarachnoid hemorrhage	13	43.33	11	36.66	1.378 0.848
▪ Acute respiratory failure	5	16.67	6	20.00	
▪ Polytrauma	7	30.00	8	26.67	
▪ Ruptured appendix	4	10.00	5	16.67	
# Past medical history					
▪ Diabetes mellitus	12	40.00	14	46.67	0.131 0.717
▪ Hypertension	9	30.00	7	23.33	
▪ Respiratory diseases	5	16.67	5	16.67	
▪ CNS diseases	10	33.33	10	33.33	
▪ Sepsis	3	10.09	3	10.09	

More than one answer was chosen

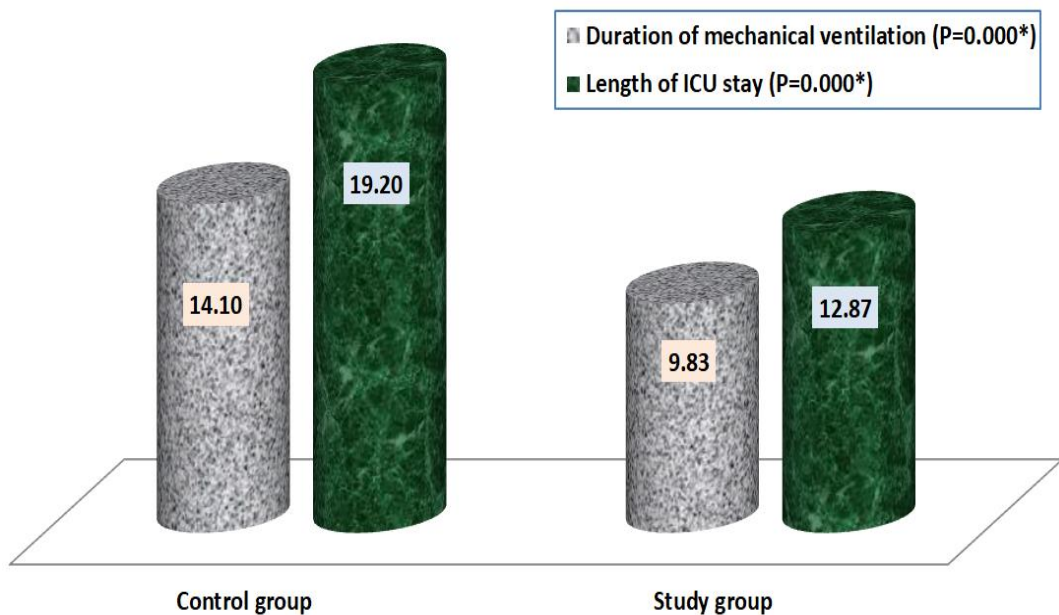
* Statistically significant at level $P < 0.05$ **Figure 1: Comparison between duration of mechanical ventilation and length of ICU stay between the control group and the study group**

Table (3): Assessment of Glasgow Coma Scale (GCS) among the studied groups throughout periods of implementation

Glasgow Coma Scale (GCS)	The studied critically ill patients (n=60)																	
	Control group (n=30)								χ^2 P	Study group (n=30)								χ^2 P
	1 st day		3 rd day		5 th day		7 th day			1 st day		3 rd day		5 th day		7 th day		
	N	%	N	%	N	%	N	%		N	%	N	%	N	%	N	%	
▪ (13-15)	11	36.67	9	30.00	7	23.33	6	20.00	20.257 0.162	10	33.33	12	40.00	13	43.33	15	50.00	22.429 0.097
▪ (9-12)	19	63.33	21	70.00	23	76.67	24	80.00		20	66.67	18	60.00	17	56.67	15	50.00	
▪ < 8	0	0.00	0	0.00	0	0.00	0	0.00		0	0.00	0	0.00	0	0.00	0	0.00	
Range	(10-15)		(10-15)		(10-14)		(10-13)		F=2.537	(10-15)		(10-15)		(10-15)		(10-15)		F=2.965
Mean ± SD	12.17±1.599		11.43±1.591		11.40±1.221		11.27±1.112		P=0.060	11.70±1.557		12.37±1.691		12.80±1.606		12.80±1.750		P=0.035*
Control Vs Study																		
T	1.145		2.202		3.801		4.051											
P	0.257		0.032*		0.000*		0.000*											

* Statistically significant at level P<0.05

Table (4): Assessment of Richmond Agitation sedation Scale (RASS) among the studied groups throughout periods of implementation

RASS scale	The studied critically ill patients (n=60)																	χ^2 P
	Control group (n=30)								χ^2 P	Study group (n=30)								
	1 st day		3 rd day		5 th day		7 th day			1 st day		3 rd day		5 th day		7 th day		
	N	%	N	%	N	%	N	%		N	%	N	%	N	%	N	%	
▪ +4	0	0.00	0	0.00	3	10.00	2	6.67	13.599 0.886	0	0.00	0	0.00	0	0.00	0	0.00	6.586 0.993
▪ +3	1	3.33	2	6.67	4	13.33	3	10.00		1	3.33	1	3.33	2	6.67	1	3.33	
▪ +2	3	10.00	3	10.00	2	6.67	3	10.00		3	10.00	3	10.00	2	6.67	2	6.67	
▪ +1	5	16.67	5	16.67	4	13.33	4	13.33		4	13.33	4	13.33	3	10.00	3	10.00	
▪ 0	12	40.00	9	30.00	7	23.33	6	20.00		11	36.67	13	43.33	15	50.00	16	53.33	
▪ -1	4	13.33	5	16.67	4	13.33	5	16.67		5	16.67	5	16.67	4	13.33	4	13.33	
▪ -2	3	10.00	3	10.00	2	6.67	3	10.00		3	10.00	2	6.67	2	6.67	2	6.67	
▪ -3	2	6.67	3	10.00	4	13.33	4	13.33		3	10.00	2	6.67	2	6.67	2	6.67	
▪ -4	0	0.00	0	0.00	0	0.00	0	0.00		0	0.00	0	0.00	0	0.00	0	0.00	
▪ -5	0	0.00	0	0.00	0	0.00	0	0.00		0	0.00	0	0.00	0	0.00	0	0.00	
Control Vs Study χ^2 P	2.248 0.896		2.061 0.914		8.638 0.280		9.873 0.196											

* Statistically significant at level P<0.05

Table (5): Assessment of delirium throughout periods of implementation among the studied groups

Delirium Assessment	The studied critically ill patients (n=60)																	
	Control group (n=30)								χ^2 P	Study group (n=30)								χ^2 P
	1 st day		3 rd day		5 th day		7 th day			1 st day		3 rd day		5 th day		7 th day		
	N	%	N	%	N	%	N	%		N	%	N	%	N	%	N	%	
CMA-ICU																		
▪ Negative	30	100.0	19	63.33	15	50.00	12	40.00	13.110	30	100.0	22	73.33	24	80.00	25	83.33	6.160
▪ Positive	0	0.00	11	36.66	15	50.00	18	60.00	0.004*	0	0.00	8	26.66	6	20.00	5	16.66	0.104
Control Vs Study χ^2 P	-----		FE 0.187		FE 0.001*		FE 0.001*											
Severity of delirium																		
▪ No delirium (0)	30	100.0	19	63.33	15	50.00	12	40.00	58.296 0.000*	30	100.0	22	73.33	24	80.00	25	83.33	17.212 0.009*
▪ Mild delirium (1-2)	0	0.00	4	13.33	3	10.00	3	10.00		0	0.00	6	20.00	5	16.66	5	16.66	
▪ Mild-Moderate (3-5)	0	0.00	3	10.00	5	16.66	6	20.00		0	0.00	2	6.66	1	3.33	0	0.00	
▪ Severe (6-7)	0	0.00	4	13.33	7	23.33	9	30.00		0	0.00	0	0.00	0	0.00	0	0.00	
Control Vs Study χ^2 P	---		5.254 0.072		21.507 0.000*		35.177 0.000*											

* Statistically significant at level P<0.05

Table (6): Assessment of family satisfaction level among the studied groups throughout periods of implementation

Family satisfaction level	The studied critically ill patients (n=60)																	
	Control group (n=30)								χ^2 P	Study group (n=30)								χ^2 P
	1 st day		3 rd day		5 th day		7 th day			1 st day		3 rd day		5 th day		7 th day		
	N	%	N	%	N	%	N	%		N	%	N	%	N	%	N	%	
▪ Low	24	80.00	25	83.33	23	76.67	24	80.00	3.04 0.804	25	83.33	18	60.00	14	46.67	10	33.33	24.91 0.000*
▪ Moderate	5	16.67	5	16.67	6	20.00	6	20.00		5	16.67	11	36.67	10	33.33	13	43.33	
▪ High	1	3.33	0	0.00	1	3.33	0	0.00		0	0.00	1	3.33	6	20.00	7	23.33	
Range	(21-61)		(21-53)		(18-57)		(15-49)		F=0.03	(18-53)		(25-58)		(28-61)		(28-62)		F=12.59
Mean ± SD	39.87±9.16		39.83±8.71		39.93±9.20		40.40±8.06		P=0.994	38.27±9.21		44.03±9.01		48.20±8.41		50.80±6.98		P=0.000*
Control Vs Study																		
t	0.675		1.836		3.634		5.343											
P	0.502		0.072		0.001*		0.000*											

(<60%) Low

(60-75%) Moderate (>75%) High

* Statistically significant at level P<0.05

Table (7): Assessment of delirium adverse events throughout periods of implementation among the studied groups

Delirium adverse events	The studied critically ill patients (n=60)																	
	Control group (n=30)								χ^2 P	Study group (n=30)								χ^2 P
	1 st day		3 rd day		5 th day		7 th day			1 st day		3 rd day		5 th day		7 th day		
	N	%	N	%	N	%	N	%		N	%	N	%	N	%	N	%	
1. None																		
▪ Present	21	70.00	19	63.33	15	50.00	12	40.00	19.987 0.000*	20	66.66	22	73.33	24	80.00	25	83.33	2.213
	9	30.00	11	36.66	15	50.00	18	60.00		10	33.33	8	26.66	6	20.00	5	16.66	0.529
Control Vs Study χ^2 P	FE 1.000		FE 0.766		FE 0.035*		FE 0.009*											
2. Removal of invasive lines																		
▪ Absent	26	86.67	24	80.00	22	73.33	23	76.66	9.739	27	90.00	26	86.67	27	90.00	30	100.00	7.606
▪ Present	4	13.33	6	20.00	8	26.67	7	23.33	0.021*	3	10.00	4	16.67	3	6.67	0	0.00	0.055
Control Vs Study χ^2 P	FE 1.000		FE 0.739		FE 0.049*		FE 0.004*											
3. Self-extubation																		
▪ Absent	30	100.00	30	100.00	30	100.00	28	93.33	5.648	30	100.00	30	100.0	30	100.0	30	100.0	4.593
▪ Present	0	0.00	0	0.00	0	0.00	2	6.67	0.130	0	0.00	0	0.00	0	0.00	0	0.00	0.204
Control Vs Study χ^2 P	-		-		-		FE 0.004*											
4. Physical injuries																		
▪ Absent	29	96.67	28	93.33	17	56.67	18	60.00	25.486	29	96.67	29	96.67	25	83.33	28	93.33	4.665
▪ Present	1	3.33	2	6.67	13	43.33	12	40.00	0.000*	1	3.33	1	3.33	5	16.67	2	6.67	0.198
Control Vs Study χ^2 P	-		FE 0.757		FE 0.037*		FE 0.009*											

* Statistically significant at level P<0.05

Table (8): Relation between RAAS scale, GCS scale and occurrence of delirium throughout periods of implementation among the studied groups

	The studied critically ill patients (n=60)															
	CMA-ICU															
	3 rd day								7 th day							
	Control group (n=30)				Study group (n=30)				Control group (n=30)				Study group (n=30)			
	Negative		Positive		Negative		Positive		Negative		Positive		Negative		Positive	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
GCS																
▪ (9-12)	13	43.33	11	36.67	11	36.67	7	23.33	8	26.67	16	53.33	11	36.67	4	13.33
▪ (13-15)	6	6.67	0	0.00	11	36.67	1	3.33	4	13.33	2	6.67	14	46.67	1	3.33
χ^2 , P	17.204 , 0.004*				7.356 , 0.196				2.821 , 0.420				3.977 , 0.553			
RAAS																
▪ -3	1	3.33	2	6.67	1	3.33	1	3.33	2	6.67	2	6.67	2	6.67	0	0.00
▪ -2	3	10.00	0	0.00	1	3.33	1	3.33	3	10.00	0	0.00	1	3.33	1	3.33
▪ -1	3	10.00	2	6.67	2	6.67	2	6.67	0	0.00	5	16.67	2	6.67	2	6.67
▪ 0	8	26.67	1	3.33	12	40.00	2	6.67	5	16.67	1	3.33	15	50.00	1	3.33
▪ 1	3	10.00	2	6.67	3	10.00	1	3.33	0	0.00	4	13.33	3	10.00	0	0.00
▪ 2	1	3.33	2	6.67	2	6.67	1	3.33	1	3.33	2	6.67	1	3.33	1	3.33
▪ 3	0	0.00	2	6.67	1	3.33	0	0.00	1	3.33	2	6.67	1	3.33	0	0.00
▪ 4	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	6.67	0	0.00	0	0.00
χ^2 , P	12.052 , 0.061				3.904 , 0.690				21.791 , 0.003*				8.462 , 0.206			

* Statistically significant at level P<0.05

Table (9): Effect of demographic characteristics of the studied groups on occurrence of delirium

Characteristics	The studied critically ill patients (n=60) CMA-ICU															
	3 rd day								7 th day							
	Control group (n=30)				Study group (n=30)				Control group (n=30)				Study group (n=30)			
	Negative		Positive		Negative		Positive		Negative		Positive		Negative		Positive	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Age (in years)																
▪ (21-<30)	5	16.67	1	3.33	3	10.00	2	6.67	5	16.67	1	3.33	5	6.67	0	0.00
▪ (30-<40)	1	3.33	2	6.67	4	13.33	0	0.00	1	3.33	2	6.67	4	13.33	0	0.00
▪ (40-<50)	2	6.67	2	6.67	3	10.00	0	0.00	2	6.67	2	6.67	3	10.00	0	0.00
▪ (50-<60)	8	26.67	1	3.33	8	26.67	3	10.00	0	0.00	9	30.00	7	23.33	4	13.33
▪ (≥60)	3	10.00	5	16.67	4	13.33	3	10.00	4	13.33	4	13.33	6	20.00	1	3.33
χ^2 , P	7.794, 0.099				5.613, 0.230				14.519, 0.006				6.871, 0.143			
Gender																
▪ Male	10	33.33	7	23.33	15	50.00	3	10.00	8	26.67	9	30.00	16	53.33	2	6.67
▪ Female	9	30.00	4	13.33	7	23.33	5	16.67	4	13.33	9	30.00	9	30.00	3	10.00
χ^2 , P	FE, 0.708				FE, 0.210				FE, 0.465				FE, 0.364			
χ^2 , P	0.926, 0.921				2.803, 0.591				5.417, 0.247				6.466, 0.167			

* Statistically significant at level P<0.05

Discussion:

Delirium is a highly prevalent neurocognitive disorder and is defined by a sudden, reversible disruption in cognition, awareness, and attention. It threatens the safety of the patients, independently increases morbidity and mortality, duration of mechanical ventilation, period of hospitalization, and worsened long-term cognitive function making it a costly and dangerous syndrome (Bisson et al., 2024).

Sensory stimulation is a non-pharmacological interventions used to prevent delirium through providing similar environment that is close to the real world. Sensory stimulation stimulates the affected neural networks and avoids sensory deprivation that could induce pain, agitation, and delirium (Xu et al., 2025). This potential motivated our study, aimed at evaluating the effect of family multisensory stimulation on the occurrence of delirium among mechanically ventilated patients.

The current findings indicated that more than half of participants in both groups were males, with approximately one-third of them aged between 50 and 60 years. This demographic trend might be attributable to males may experience more risk factors intimately associated with impairment in cognitive-related brain domains, like obstructive sleep apnea, alcohol dependence, and psychological stress for disease which may be the main causes of delirium. However, the specific mechanism of gender associated with delirium is still unclear. Moreover, delirium more often affects men amongst patients < 65 years old and more frequently affects women in the age group of ≥ 85 years (Wang et al., 2021; Zhang et al., 2024).

This concurs with Elcokany & Ahmed, (2019) who revealed that more than three quarters of patients in the control and intervention group aged less than 69 years old. Also, this aligns with prior evidence from Liang et al., (2023) & Adineh et al., (2023) who reported that male was more common than females. Additionally, Sedghi, Ghaljeh, Faghihi, & Sarani, (2020) stated that more than half of the sample was males.

However, this finding diverges from those by Contreras et al., (2021) who revealed that majority of participants' age was above 60 years.

The results indicated that daughters were the most significant family member stayed with the patients and performed the sensory stimulation program for the patient in the study group. This concurs with Elcokany & Ahmed, (2019) who documented that daughters were the most significant family member stayed with the patients. However, Adineh et al., (2023) revealed that fathers were the most significant family members stayed with the patients and performed sensory stimulation all over their hospitalization period.

The current study findings presented that number of visitors was the same in both groups. However, the incidence of delirium was significantly higher in the control group and this may be due to family members in the intervention group implemented multi-sensory stimulation during their targeted visits.

Multi-sensory stimulation provides cognitive stimulation and more alertness thus creating a healing environment and the incidence of delirium was reduced (Shinohara, Unoki, & Horikawa, 2022). This result was in alignment with Rosa et al., (2019) who revealed that both groups had an equal number of the visitors.

In terms of current diagnosis, majority of the control and study groups were recruited to ICU due to subarachnoid hemorrhage. This could due to the nature of the current study setting (surgical ICU) that received the subarachnoid patient in the postoperative phase. These results were in agreement with Yousefi, Naderi, & Daryabeigi, (2015) who similarly observed subarachnoid hemorrhage was the most significant diagnosis in the studied groups. Although, Adineh et al., (2023) found that the most common diagnosis in both groups was intracerebral hemorrhage. Also, Gerber et al., 2019 found that majority of ICU patients had cardiac surgeries.

By examining comorbid conditions, it was found that diabetes mellitus was the most common past medical history in the study group

and the control group. These comorbidities align with established associations between participants' age (most of them were in the age group from 30 to 60 years) and the diabetes is most prevalent in this age. Moreover, the prevalence of type 2 diabetes mellitus is increasing in both sex, but men are usually diagnosed at a younger age and lower body fat mass than women. Worldwide, an estimated 17.7 million more men than women have diabetes mellitus **(Kautzky-Willer, Leutner, & Harreiter, 2023)**.

Similar conclusions were drawn by Nesbit & Agrawal, (2023) who identified that diabetes mellitus was the most common past medical history in the studied groups. Though, the current findings contrasted with Ahmed, Attia, Mansour, & Megahed, (2023), who found that cardiovascular and respiratory diseases were more prevalent.

In the context of duration of mechanical ventilation and length of ICUstay, the current study findings revealed that duration of mechanical ventilation and length of ICUstay were significantly reduced in the study group than in the control group. These results may be due to implementation of family multisensory stimulation which significantly decreased the incidence of delirium which was strongly linked to the duration of mechanical ventilation and length of ICUstay.

These findings concur with Gerber et al., (2019) and Chen et al., (2021) who concluded that duration of mechanical ventilation and length of ICUstay were significantly lower in the intervention group than in the control group.

Concerning level of consciousness, the current study findings concluded that conscious patients (GCS 13-15) were significantly higher in the study group compared to the control group during the fifth and seventh follow up days.

This observation resonates with Miranda et al., (2023) and Şanlıtürk et al., (2023) who found that majority of the study group patients had higher GCS score than the control group patients.

Regarding Richmond Agitation sedation Scale, the current results described that calm and cooperative category (category 0) of RASS scale was predominant category in the study group compared the control group during the fifth and seventh follow up days. However, this difference was not statistically significant.

This observation was in the same line with Naef et al., (2021) who stated that no statistical significant differences were found between the two studied groups regarding RASS during the follow up days.

Regarding incidence of delirium, the current study revealed that delirium was significantly higher in the control group than in the study group. This finding could be explained by control group patients' deprivation from balanced sensory stimuli which cause losing integrity of human behavior which can lead to delirium. Families can implement a sensory stimulation program that offers ICU patients a rich environment full of balanced sensory stimuli to promote patients' recovery, restore nerve function and prevent delirium **(Schwanda & Gruber, 2018)**.

This result was corroborating the results of Şanlıtürk et al., (2023), Faustino et al., (2022), and Momeni, Arab, Dehghan, Ahmadinejad, (2021) who showed that there were longer delirium-free days among participants in the intervention group than in the control group. Additionally, Alvarez et al., (2020) showed a significant reduction of delirium in the study group compared to the control group.

Additionally Chen, Ding, & Wang, (2024) investigated the effects of cognitive stimulation therapy and reported significant differences in delirium incidence between both groups. However, Liang et al., (2023) showed fewer patients with delirium in the intervention group than in the control group, although statistical significance was not reached.

Regarding delirium severity, post implementing family multi-sensory stimulation, delirium severity was significantly lower in the intervention group than the control group during the fifth and the seventh follow

up days. This could be attributed to sensory stimulation's capacity to activate the sensory area of the brain, regulate various biological mechanisms, increase the activity of the cerebral cortex, increase attention and response to stimulation, effectively promote cognition and restore sensory deprivation **(Ma, Cui, Guo, Zhang, & Jin, 2024)**.

These outcomes align with findings by Liang et al., (2023) and Fatima, Hill, Dover, and Faisal, (2024) who concluded that sensory stimulation significantly reduced delirium severity in the study group. Also, Chen et al., (2021) and Faustino et al., (2022) concluded that severity of delirium was lower in the intervention group than in the control group.

Concerning adverse events of delirium, significant differences were observed across various categories; removal of invasive lines, self extubation, and physical injuries. These findings explain that a higher percentage of the study group had minimal adverse events of delirium compared to the control group. This may be attributed to the effect of family multi-sensory stimulation which reduced the incidence of delirium and so, delirium adverse events were reduced consequently **(Attwell et al., 2019)**.

This result is in the same line with Shou et al., (2021) who stated that delirium adverse events were significantly lower in the study group than in the control group. Moreover, Miranda et al., (2023) revealed that removal of invasive lines and physical injuries were significantly lower in the intervention group. Also, Şanlıtürk et al., (2023) found that adverse events of delirium were significantly lower in the intervention group.

The current study findings revealed that family satisfaction levels were significantly higher in the study group than in the control group. This result could be attributed to effective communication between the researchers and the family members which is vital for understanding nature of the patient's diseases, treatment plans, and nursing care.

Additionally, family members in the study group were allowed to visit the patients more frequently and implemented multisensory stimulation which reduced the incidence of delirium and so all of the previous causes made family members in the intervention group significantly satisfied **(Liang, Chau, Lo, Zhao, & Liu, (2022))**.

This result was in alignment with Ma, Cui, Guo, Zhang & Jin, (2024), Adineh et al., (2022), Gerber et al., (2019), and Jitpanya, (2017) who found that family satisfaction was significantly higher in the intervention group.

Regarding the relation between Glasgow Coma Scale (GCS) score and the occurrence of delirium, the study findings concluded that a statistical significant relation was found within the control group regarding GCS scale and the occurrence of delirium during the third follow up day. While, no statistical significant relations were found within the study group regarding GCS scale and the occurrence of delirium during the third and seventh follow up days. This result could be due to CAM-ICU scale used for staged assessing occurrence of delirium adopts a approach to assessment.

Delirium is defined in terms of four diagnostic criteria (changes in mental status, inattention, the current level of consciousness, and disorganised thinking). So, diagnosis of delirium is not dependant only on GCS score **(Fong & Inouye, 2022)**.

This result was contradicted by Alattar, Nouman, Onyike, Stasieluk, & Meresh, (2024) who revealed that low GCS score during ICU admission in intubated patients had significant relation with delirium, and these patients had longer ICU and hospital stays.

Additionally, the study findings revealed that significant effects of RASS scale on the occurrence of delirium was found in the control group compared to the study group during the seventh follow up day. This result was in the same line with Liang et al., (2023) who found significant relation between RASS scale and the occurrence of delirium.

Concerning effect of age on delirium, age had significant effect on occurrence of delirium in the control group compared to the study group during the seventh follow up day. This result was supported by Kubota et al., (2018) who observed that age was the strongest factor in developing delirium in the control group than in the study group.

Additionally, the study findings described that gender has no significant effect on the occurrence of delirium in the control group and the study group during the third and seventh follow up days. This finding was in the opposite line with Wittmann, Kirfel, Jossen, Mayr, & Menzenbach, (2022) who found significant impact of male gender on the occurrence of postoperative delirium in both studied groups.

In summary, this study substantiates the potential of multisensory stimulation in reducing delirium incidence, severity, adverse events, duration of mechanical ventilation, length of ICU stay, and enhancing family's satisfaction for mechanically ventilated patients. Further exploration with larger cohorts and long-term follow-up is warranted to fully delineate the therapeutic scope of multisensory stimulation in mechanically ventilated patients.

Conclusion

In conclusion, the findings of this study indicated that the study group demonstrated significantly greater reductions in delirium incidence, severity, and adverse events such as removal of invasive lines during the fifth and seventh days post-implementing multisensory stimulation, as well as significant reductions in duration of mechanical ventilation and ICU stay compared to those who received routine ICU care. Additionally, family members who implemented the multisensory stimulation under the guidance of the researchers showed significant increase in their satisfaction levels during the fifth and seventh days post post-implementing multisensory stimulation than families of the patients who received routine ICU care.

Recommendations

Based on the findings of this study, implementing multisensory stimulation for mechanically ventilated patients by the family members is crucial to reduce incidence and severity, and adverse events of delirium, reduce duration of mechanical ventilation and length of ICU stay. Replicating this study with a larger, representative sample is suggested to further validate and generalize these findings.

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