ORIGINAL ARTICLE

# Pain among mechanically ventilated patients in critical care units

**Manal M. Al Sutari, Maysoon S. Abdalrahim, Ayman M. Hamdan-Mansour[1], Shahnaz M. Ayasrah[2]**

Faculty of Nursing, Clinical Nursing Department, The University of Jordan, Amman, Jordan, [1]Faculty of Nursing, Community Health Nursing, The University of Jordan and Al Farabi College for Dentistry and Nursing, Riyadh, KSA, [2]Faculty of Nursing, Department of Applied Science, Al-Balqa' Applied University (Ajloun University College), Amman, Jordan

**Background:** Pain is a common experience among mechanically ventilated patients. Pain among mechanically ventilated patients is aggravated by factors such as stage of illness, invasive procedures, and surgical interventions. The aim to this study was to investigate pain levels and predictors among mechanically ventilated patients during rest and routine nursing interventions. **Materials and Methods:** A cross-sectional descriptive correlational design was used, with a total sample of 301 mechanically ventilated patients. Patients' pain levels were assessed using Behavioral Pain Scale during rest and routine nursing interventions. **Results:** The mean pain score levels during rest (mean = 3.69, standard deviation [SD] = 0.81) were lower than mean pain score levels during routine nursing interventions (mean = 7.1, SD = 2.5). During rest, pain scores were significantly correlated with age ($r = -0.12$, $P = 0.046$), and heart rate ($r = 0.24$, $P < 0.001$). During nursing interventions, pain scores were significantly correlated with age ($r = -0.25$, $P < 0.001$), heart rate ($r = 0.36$, $P < 0.001$), and diastolic blood pressure (BP) ($r = 0.21$, $P < 0.001$). The age and past surgical history were found to be significant (age: $\beta = -0.009$, $P = 0.002$; past surgical history: $\beta = -1.376$, $P < 0.001$). **Conclusion:** Mechanically ventilated patients experience pain during rest as well as during routine nursing interventions. Pain levels were associated with age, heart rate, and diastolic BP. The age and past surgical history should be considered as important predictive factors.

**Key words:** Critical care units, mechanically ventilated patients, pain assessment

**How to cite this article:** Al Sutari M M, Abdalrahim M S, Hamdan-Mansour A M, Ayasrah S M. Pain among mechanically ventilated patients in critical care units. J Res Med Sci 2014;19:726-32.

## INTRODUCTION

Pain is a commonly reported experience among mechanically ventilated patients that influences their health status.[1-3] Critical care patients in Jordan ranked pain as their second greatest stressor.[4] Previous studies showed that pain among patients in critical care units is aggravated by number of factors such as stage of illness, exposure to multiple invasive procedures, and surgical interventions.[5,6] Moreover, patients in critical care units are subject to intensive nursing care interventions such as repositioning, breathing and coughing exercises, tracheal suctioning, and line removals that add to their painful experiences.[7-9] The increased pain level among patients will, consequently, result in deteriorating the respiratory and cardiac functions, increase morbidity and mortality, prolong the recovery period, and increase health care costs.[2,8,10] Despite advancements in pain management, pain remains a significant problem for mechanically ventilated patients in critical care units.[11,12] Adequate pain assessment and management for critically ill patients presents a unique challenge to nurses and to researchers in the field.[13] Patients in critical care units may experience a number of neurophysiological and communication disabilities that may result in underestimating their pain level.[14,15] Pain treatment in critical care patients requires that critical care nurses should have the knowledge and skills for accurate and reliable measure of their patients' pain rather than rely only on patients' behaviors.[14,16]

Although the literature has emphasized the significance of adopting accurate and reliable pain assessment methods for patients in critical care units, particularly those on mechanical ventilation, the Jordanian studies have limited information for this issue. Previous Jordanian studies have focused on perceptions and knowledge among health professionals, while patients have been ignored.[17,18] since the year 2009, Jordanian hospitals became interested in accreditation and quality care assurance. Accordingly health care institutions have increased their awareness for the requirement of established protocols in clinical settings related to pain assessment and management.[18] Therefore, the purpose of this study was to investigate pain levels and associated factors contributing to pain among patients

**Address for correspondence:** Dr Manal M. Al Sutari, Department of Clinical Nursing, The University of Jordan, Amman - 11942, Jordan.
E-mail: manal.sutari@ju.edu.jo
**Received:** 24-12-2013; **Revised:** 22-01-2014; **Accepted:** 01-07-2014

on mechanical ventilation in critical care units during rest and during routine nursing intervention.

## MATERIALS AND METHODS

Descriptive correlational design utilized to collect data related to mechanically ventilated patients in critical care units during rest and during caring interventions in three major hospitals in Jordan. Data were collected using structured — observational method. Data were collected between October 2012 and March 2013.

A total of 301 patients on mechanical ventilation recruited from the critical care units at three major hospitals in Jordan. The targeted units were medical Intensive Care Unit (ICU), surgical ICU, coronary care units, and neuro-ICU. Hospitals were selected randomly among all hospitals in Jordan (108 hospitals) using stratification technique according to the geographic areas (North, Center, and South), and their type of the three main health care sectors in Jordan (academic, public, and military). Three hospitals were selected using simple random method where each hospital represented one health care sector and geographical area. The eligibility criteria for including patients in the study were; being 18 years or older; being unconscious and mechanically ventilated for at least 48 h; without quadriplegia, peripheral neuropathy, or receiving neuromuscular blocking agents.

Prior data collection, ethical approvals were obtained from the research committee at the Faculty of Nursing at the University of Jordan, and from the targeted hospitals. A liaison from each hospital has been assigned to approach delegated families to inform them about the study in addition to a flyer about the study posted at the announcement boards. Those who expressed interest in the study have been approached by a researcher who was available at the area. The researcher provided the families information about the purpose of the study, its significance, what is expected, and type of data that will be collected. In addition, the families were assured that confidentiality of data and that participation in the study is voluntarily and that their approval or no-approval to participate in the study will not influence the quality of care provided. Families then were asked to sign the informed consents after having all their questions answered. The consent forms included information related to the purpose of the study, its significance, and the contact information of the principal investigator. The consent forms were co-signed with witnesses who clinicians were working in the units. Patients of family members who agreed to participate and signed consent forms were approached and assessed for eligibility. For consistency, all procedures were performed by the trained research assistants who were nurses with experience in critical care nursing and pain management.

Patients' pain levels were assessed using Behavioral Pain Scale (BPS) developed by Payen *et al*.[19]

The researchers assessed patients' pain levels using the BPS before initiating the routine nursing interventions. The same researchers assessed patients' pain levels during the routine nursing interventions using the same scale. Measures of patients' health status, such as; heart rate, diastolic blood pressure (BP), systolic BP, respiratory rate, and oxygen saturation, were measured and recorded during rest and during the routine nursing interventions. Examples of routine nursing interventions were repositioning, endotracheal suctioning, intravenous access insertion, mouth care, eye care, and nasogastric tube insertion. Inter-rater reliability between the two researchers achieved on a sample of 45 (15%) of patients and the agreement was 100%. Those who met the inclusion criteria were screened and assessed using the BPS. An identification number was assigned for each patient at the beginning of the study and data were kept confidential by the investigators. Files were kept in locked cabinets at the Faculty of Nursing. All projects' electronic versions were kept in the primary investigator's computer.

### Instruments

Pain was assessed using the BPS developed by Payen *et al*. The BPS is a 12-item scale that evaluates pain on three behavioral indicators: Facial expressions, movement of upper limbs, and compliance with ventilation. Each behavioral indicator contains 4 descriptors rated on a 1-4 scales. The total score ranges from 3 (no pain) to 12 (highest level of pain). The scale has high inter-rater reliability (0.95).[20] In addition, Ramsay scale was used to assess sedation level. This scale rates sedation levels on a scale from 1 to 6, with higher levels indicating greater degrees of sedation.[21]

A clinical tool developed by the study researchers was used to collect patient demographics and health histories from the medical records. Information related to patient demographics and personal characteristics included age, gender, and medical diagnoses including the primary and secondary diagnosis at the time of admission, as well as past medical and surgical histories. The same tool recorded information related to measures of health status such as heart rate, diastolic BP, systolic BP, respiratory rate, and oxygen saturation.

### Data analysis

The Statistical Package for Social Science (SPSS 15, Inc., Chicago, Illinois) was used to analyze the data. Variables were described using the central tendency measures (means, and medians), and the dispersion measures (standard deviation [SD] and ranges). Pearson correlation

coefficient (*r*) was used to examine the relationship between the variables. Differences in pain scores during rest and during routine nursing interventions related to selected personal and demographic variables were compared using a paired — samples *t*-test for two independent samples and ANOVA.

Two-step multiple hierarchal regression analysis was used to identify the optimal set of predictors for the pain level during rest and during routine nursing interventions. Personal characteristics (age, gender, medical diagnoses, past medical and past surgical history) were entered in Model I to control and examine their effect on prediction power and on the predictors (methods of ventilation and type of airway used for ventilation). Variables such as systolic and diastolic BPs, heart rate, respiratory rate, and oxygen saturation were entered in Model II using alpha at 0.05. To ensure meeting all assumptions for the analysis used, the variables were tested for outliers, multicollinearity and singularity, normality, linearity, homoscedasticity, and independence of residuals.

## RESULTS

A total of 301 critically ill mechanically ventilated patients were surveyed for their pain levels using the BPS. About 62% (*n* = 187) were male, while 38% (*n* = 114) were female. The mean sample age was 60.8 years (SD = 16.7), with age ranging from 18 to 90 years. 65% (*n* = 197) had a medical diagnosis, while 12% (*n* = 37) had past surgical history. Approximately 38% (*n* = 113) were diagnosed with comorbidities of hypertension and diabetes mellitus, and 20% (*n* = 59) had cardiac diagnoses. 87% (*n* = 263) were ventilated through endotracheal tube, while 13% (*n* = 38) were ventilated through tracheostomy. About 40% of the sample (*n* = 120) were sedated during assessment, while 60% (*n* = 181) were not.

### Pain level

Pain levels were examined among critically ill mechanically ventilated patients, and the pain levels were compared during rest and routine nursing interventions. The mean pain score levels during rest (mean = 3.69, SD = 0.81) were lower than mean pain score levels during routine nursing interventions (mean = 7.1, SD = 2.5). The paired *t*-test of these pain mean scores (mean difference = 3.41) were statistically significant. This difference in pain mean scores was statistically significant in paired *t*-test ($t = -28.7$, $P < 0.001$).

### Factors contribute to pain intensity

Pearson *r* and *t*-test were used to examine if pain levels differed according to the patients' demographic and personal characteristics [Table 1]. Results indicated that pain levels during rest were significantly and negatively correlated with age ($r = -0.12$, $P = 0.046$). Older patients' were less likely to have pain than younger ones. No significant difference in pain level was found during the rest with regard to other demographic characteristics (gender, medical history, past surgical history, and methods of ventilation). Heart rate during rest was significantly and positively correlated with pain level ($r = 0.24$, $P < 0.001$). However, no significance was found for other measures of health status such as systolic BP, diastolic BP, respiratory rate, and oxygen saturation [Table 1].

**Table 1: Relationship between pain level during rest and during routine nursing interventions and the demographic characteristics and measures of health status among mechanically ventilated patients on (*n* = 301)**

| Variable | Correlation | |
|---|---|---|
| | Pearson (r) | *P* value |
| Pain during rest | | |
| Age | −0.12 | 0.046 |
| Heart rate | 0.24 | <0.001 |
| Diastolic blood pressure | 0.016 | 0.783 |
| Systolic blood pressure | −0.06 | 0.319 |
| Respiratory rate | 0.05 | 0.210 |
| Oxygen saturation | 0.04 | 0.33 |
| Pain during routine nursing intervention | | |
| Age | −0.25 | <0.001 |
| Heart rate | 0.36 | <0.001 |
| Diastolic blood pressure | 0.21 | <0.001 |
| Systolic blood pressure | 0.11 | 0.068 |
| Oxygen saturation | 0.09 | 0.072 |

During routine nursing interventions, significant and positive correlation to pain levels occurred in diastolic BP and heart rate. Age was significantly and negatively correlated with pain during routine nursing interventions [Table 1]. This would indicate that older patients tended to have less pain than younger ones. Patients during routine nursing interventions who had a higher level of pain were more likely to have higher diastolic BP and heart rate. This correlation ranged from 0.21 (diastolic BP) to 0.36 (heart rate). Correlation magnitude and significance level were stronger and higher during routine nursing interventions than during the rest. Significant differences in pain level existed during routine nursing interventions according to gender and past health history (medical history versus surgical history).

The analysis showed that male patients with a medical diagnosis had a higher level of pain than those with surgical diagnosis. ANOVA indicated that there was a significant difference in pain level among patients in regards to the type of routine nursing interventions $F$ (4,300) = 108.3, $P < 0.001$. The highest mean scores occurred among patients who were repositioned (mean = 9.13, SD = 1.59), then

suctioned (mean = 8.29, SD = 1.87), than those who had invasive procedures (mean = 6.24, SD = 1.67), and had mouth care (mean = 5.24, SD = 1.21). The lowest mean score was among patients who had eye care (mean = 3.80, SD = 0.87). Interestingly, repositioning recorded the highest pain level, even more than invasive procedures. Yet repositioning is considered a routine and minor nursing intervention.

### Predictors of pain during rest and during caring interventions

To investigate the predictors of pain among mechanically ventilated patients during rest and during routine nursing interventions, two-step multiple hierarchal regression analysis was conducted. For predicting pain level during rest, the selected personal characteristics (age, gender, medical diagnoses, past medical history, and past surgical history) were entered into the block I as controlled variables to determine the possible changes in pain level as the demographic characteristics were entered. Predictors (methods of ventilation, systolic BP, diastolic BP, heart rate, respiratory rate, and oxygen saturation level) were entered in block II [Table 2]. The analysis showed that Model I explained approximately 10% ($R^2$ = 0.102) of the variance in pain level during rest. Age (β = −0.009, $P$ = 0.002) and past surgical history (β = 0.342, $P$ < 0.001) were significant predictors of pain during rest. There was a negative association between age and pain levels during rest indicating older patients were more likely to have a lower level of pain. In contrast, there was a positive association with past surgical history indicating those who had a past history of surgical interventions were more likely to have pain. As the measures of health status were entered second to the model after controlling for personal characteristics, the inclusion of these variables increased the amount of the explained variance from 10% (Model I) to 19% ($R^2$ = 0.190) in Model II. The $R^2$ change from Models I to II was 0.088 which was a statistically significant change ($P$ < 0.001). Only the past surgical history remained significant in Model II. In addition, heart rate was a significant predictor of pain during rest. A positive association between heart rate and pain indicated that patients with an elevated heart rate were more likely to have a higher level of pain during rest. Patients who had a past surgical history and had an elevated heart rate were more likely to experience a higher level of pain during rest. Past history of surgical interventions was the most significant predictor of pain during rest. Conversely, no significance was found for other measures of health status such as systolic BP, diastolic BP, respiratory rate, and oxygen saturation [Table 2].

With regard to pain level during routine nursing interventions, the same process was followed by entering personal characteristics first to be controlled and then the measures of health status using two-step multiple hierarchal regression analysis [Table 3]. The analysis showed that Model I explained approximately 12% ($R^2$ = 0.124) of the variance in pain level during routine nursing interventions. Age (β = −0.047, $P$ < 0.001) and medical diagnosis (β = −0.725, $P$ = 0.014) were the significant predictors of pain during routine nursing interventions in Model I. The negative association between age and medical diagnosis with pain during routine nursing interventions indicated that older patients and those who were not diagnosed with medical diseases were more likely to experience a higher level of pain during these interventions.

**Table 2: Multiple hierarchal regression of pain during rest on measures of health status and demographic characteristics of mechanically ventilated patients**

| Variables | Model I | | Model II | |
|---|---|---|---|---|
| | *B* | *P* value | *B* | *P* value |
| Age | −0.009 | 0.002 | −0.006 | 0.065 |
| Gender | 0.033 | 0.740 | −0.064 | 0.514 |
| Medical diagnosis | −0.051 | 0.559 | −0.074 | 0.445 |
| Past medical history | 0.368 | 0.268 | 0.152 | 0.648 |
| Past surgical history | 0.342 | <0.001 | 0.355 | <0.001 |
| Methods of ventilation | | | 0.069 | 0.626 |
| Systolic blood pressure | | | −0.002 | 0.509 |
| Diastolic blood pressure | | | 0.004 | 0.351 |
| Heart rate | | | 0.009 | <0.001 |
| Respiratory rate | | | 0.005 | 0.267 |
| Oxygen saturation | | | 0.007 | 0.674 |
| Model | $R^2$ | Adjusted $R^2$ | $R^2$ change | *P* value |
| Model I | 0.102 | 0.085 | | |
| Model II | 0.190 | 0.153 | 0.088 | <0.001 |

**Table 3: Hierarchal multiple regression of pain during routine nursing interventions on measures of health status and demographic characteristics of mechanically ventilated patients**

| Variables | Model I | | Model II | |
|---|---|---|---|---|
| | *B* | *P* value | *B* | *P* value |
| Age | −0.047 | <0.001 | −0.013 | 0.049 |
| Gender | 0.330 | 0.264 | 0.035 | 0.862 |
| Medical diagnosis | −0.725 | 0.014 | 0.323 | 0.119 |
| Past medical history | 0.337 | 0.733 | −0.853 | 0.212 |
| Past surgical history | 0.351 | 0.100 | 0.304 | 0.032 |
| Methods of ventilation | | | 0.461 | 0.109 |
| Systolic blood pressure | | | 0.005 | 0.297 |
| Diastolic blood pressure | | | 0.005 | 0.593 |
| Heart rate | | | 0.006 | 0.194 |
| Respiratory rate | | | 0.013 | 0.179 |
| Oxygen saturation | | | 0.058 | 0.108 |
| Type of routine nursing interventions | | | −1.376 | <0.001 |
| Model | $R^2$ | Adjusted $R^2$ | $R^2$ change | *P* value |
| Model I | 0.124 | 0.106 | – | |
| Model II | 0.633 | 0.615 | 0.509 | <0.001 |

As the measures of health status were entered second to Model II after controlling the personal characteristics, the inclusion of these variables increased the amount of the explained variance from 12% (Model I) to 63% ($R^2 = 0.633$) in Model II. The $R^2$ change from Model I to II was 0.51, which was highly significant change ($P < 0.001$). Age remained significant in Model II, but had a lower significance value. Although past surgical history was not significant in Model I, it appeared to be a significant predictor in Model II. Those with past surgical history were more likely to have a higher level of pain during routine nursing interventions. Type of routine nursing interventions was the significant predictor in Model II ($\beta = -1.376$, $P < 0.001$). While performing routine nursing interventions, the pain level was higher according to the following descending order: Repositioning, suctioning, invasive interventions, mouth care, eye care, and nasogastric tube insertion.

Age, past surgical history, and type of routine nursing interventions were significant predictors of pain during routine nursing interventions. The type of intervention was the most powerful predictor of pain level.

## DISCUSSION

This study investigated the level of pain and its associated factors among mechanically ventilated patients during rest and during routine nursing interventions. This study is the first one of its kind in Jordan. Findings of this study indicated that mechanically ventilated patients experience pain during rest and during routine nursing interventions. The mean score of pain during routine nursing interventions was notably and statistically higher than the mean score during rest. This difference was statistically and clinically significant. It would be expected differences in pain levels would occur during rest and during routine nursing interventions. However, this significant difference raises questions about clinicians' ability in accurately assessing the pain level of their interventions when caring for critically ill mechanically ventilated patients. In addition, it was found that critically ill mechanically ventilated patients do experience pain, and some routine nursing interventions exacerbate pain among those patients. The results of this study correspond with previous studies which showed that pain is not adequately relieved in critically ill patients.[1,8,12] For example, Li and Puntillo[3] reported that approximately 40% of critically ill patients do experience moderate to severe pain, and these researchers emphasized the need to develop health care professionals' skills in assessing and managing pain among critically ill patients.

The analysis indicated that age was negatively correlated with pain level during rest, indicating younger patients had a higher level of pain. These findings were consistent with those of Arroyo-Novoa *et al*.,[7] who found that younger patients reported higher pain levels during tracheal suctioning. However, the patients in the Arroyo-Novoa *et al*., study were conscious, while in this study 40% were under-sedation. In general, previous studies are controversial in terms of the relationship between pain level and age. Whereas Stotts *et al*.[22] have reported that younger patients experienced higher pain intensity before and after wound care, in another study, Stotts *et al*.[23] found that no difference in pain intensity existed between younger and older patients before and after routine procedures. This implies other factors may have a significant role in determining the intensity of pain among patients before and after routine nursing interventions.

This study found pain intensity positively correlated with increases in heart rate and diastolic BP during routine nursing interventions. These findings are consistent with international reports of heart rate and BP being associated with pain.[8,10,19,24] In contrast, Arbour and Gélinas; Arbour *et al*.[25,26] found that vital signs were not considered valid indicators of pain levels in critically ill patients. However, when patients lack the ability to report their pain level, observation of patients' physiological status is considered a valid approach to quantify pain levels. This study measured pain levels and associated pain contributing factors during rest, and routine nursing interventions among critically ill mechanically ventilated patients. Increases in heart rate and diastolic BP might be considered reliable physiological indicators for pain intensity that health care professionals may rely upon during caregiving.

To ensure the ability of the selected demographic characteristics and measures of health status to predict pain level during rest and during routine nursing interventions, two-step multiple hierarchal regression analysis showed that heart rate and past surgical history were powerful predictors of pain during rest. This confirmed the association between increased heart rate, past surgical history and pain. The results indicated that health care professionals have a responsibility to investigate patient's past experience with any painful surgical interventions before deciding upon appropriate pain management intervention.

During routine nursing interventions, age, past surgical history, and type of interventions were powerful predictors of pain. This raised a question regarding the actual experience of pain during the interventions and the one before the interventions. In other words, patients during rest (before interventions) were most likely to experience pain if they had past surgical history, and had increased heart rate. However, during routine nursing interventions, older patients with past history of surgical intervention or who had repositioning and suctioning, were more likely to experience higher levels of pain.

The most powerful predictors of pain during routine nursing interventions were repositioning and suctioning. These results support the documented findings reported by Puntillo *et al*.,[27] who examined pain and distress associated with different procedures commonly encountered by acute or critically ill patients and found that routine procedures such as turning (repositioning) and tracheal suctioning were the most painful and distressing. The results imply that health care professionals should consider the type of procedure and intervention, while planning for pain management in mechanically ventilated patients in critical care units.

On the other hand, the literature emphasized that lack of administering medications prior routine procedures such as nursing interventions might be due to the assumption that pain caused by these procedures is often temporary and is of no real concern.[7,27,28] As these procedures are unavoidable, it suggests that health care professionals follow clinical practice guideline recommendations regarding initiating pain treatment before routine procedures,[5,14] as well as treating pain when anticipated.[29]

Results of this study must be cautiously considered. One limitation is that many of the study patients were under-sedation. Another limitation was the lack of the BPS psychometric testing properties. Further studies are suggested to test the psychometric properties of the BPS to further confirm how it measures pain. A study comparing pain between conscious and unconscious patients on mechanical ventilation may enhance our understanding of pain experience among these critically ill individuals.

## CONCLUSION

The results of this study have implications for clinicians and researchers concerned about patients' pain in critical care units. Critically ill mechanically ventilated patients experience pain at rest as well as during routine nursing interventions. Pain level was associated with age, measures of health status, and type of routine nursing interventions. Pain predictors at rest were past surgical history and heart rate. Age, past surgical history, and type of routine nursing interventions were the significant predictors of pain during these interventions.

This study provides additional knowledge of factors causing pain among critically ill patients. In these vulnerable patients, and in the absence of subjective expressions of pain, nurses and health care professionals must rely on pain indicators and predictors to achieve appropriate pain management. Moreover, the age and past surgical history should be considered as important predictive factors in pain assessment and management. Further studies should include qualitative approaches to provide in-depth description of nurses and health care professionals' perception toward pain management in critically ill mechanically ventilated patients in critical care settings.[30]

## ACKNOWLEDGMENT

The authors would like to acknowledge the University of Jordan for facilitating obtaining the ethical permission ethical permission (project no: (113 56); the authors also would like to extend thanks to the selected hospitals for facilitating the data collection.

## AUTHORS' CONTRIBUTION

MA contributed in the conception of the work, conducting the study, revising the draft, approval of the final version of the manuscript, and agreed for all aspects of the work. MA contributed in the conception of the work, drafting and revising the draft, approval of the final version of the manuscript, and agreed for all aspects of the work. AH contributed in the conception of the work, conducting the study, revising the draft, approval of the final version of the manuscript, and agreed for all aspects of the work. SA contributed in the conception of the work, revising the draft, approval of the final version of the manuscript, and agreed for all aspects of the work.

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**Source of Support:** Nil, **Conflict of Interest:** No conflict of interests.