

Incidence and Outcomes of Pain among Critically Ill Patients

Asmaa Ayoub Yaseen¹, Mogedda Mohamed Mehany², Ahmed Mohamed Ali Mahmoud Esmaeel³ & Safaa Mohamed Adam Tozer⁴

¹ Demonstrator at Critical care and Emergency Nursing, Faculty of Nursing, Sohag University, Egypt.

² Professor of Critical Care and Emergency Nursing, Faculty of Nursing, Assuit University, Egypt.

³ Lecturer of Anesthesia and Intensive Care Unit, Faculty of Medicine, Sohag University, Egypt.

⁴ Lecturer of Critical Care & Emergency Nursing, Faculty of Nursing, Sohag University, Egypt.

Abstract:

Background: Pain is a prevalent complaint among critically ill patients, insufficient pain diagnosis and treatment can lead to slower healing and prolonged recovery. So, to achieve the optimal results, nurses must document assessments of pain accurately and completely. **Study aim:** Assesses incidence and outcomes of pain on critically ill patients. **Research design:** Cross sectional descriptive research design. **Setting:** The study was conducted at Sohag University Hospitals at (general, trauma, neuro, coronary and respiratory care units). **Sample:** A convenience sample of adult critically ill patients recently admitted to critical care units during the period from October 2023 to March 2024 **Tools:** Patient assessment tool, and patients' outcome tool. **Results:** The bulk of the studied individuals were males aged more than 50 years old, also, more than half of patients (58.4%) experienced pain, and longer intensive care units staying. **Conclusion:** The incidence of pain among patients is very high. Moreover; a significant relation was founded between pain and length of stay. **Recommendations:** Implementing a routine schedule for pain assessments in critical care units

Keywords: Critically ill, Incidence, Outcomes & Pain.

Introduction:

Pain is "an unpleasant sensory and emotional experience associated with actual or potential tissue damage; it may be acute or chronic, and both are required, necessitating a systematic and careful approach to assessing and managing pain in the intensive care units (ICUs). (Pota et al., 2022).

Critical illness is frequently painful due to the underlying cause of the disease as well as the procedures required for monitoring and treatment of these individuals. Pain is also a fundamentally subjective sensation, meaning that no two people will likely feel or react to the same painful event in the same way. (Nordness et al., 2021)

Critically ill patients may experience pain from a range of sources, such as surgical incisions, tissue trauma and positioning, underlying medical conditions, endotracheal intubation, chest tube insertion, central line placement, or wound care procedures; ventilator-associated pain; psychological factors such as stress, anxiety, or depression related to their critical illness; hospitalization; and medication side effects. (Emsden et al., 2020)

Critically ill patients' perceptions of pain can be influenced by a number of factors, such as age, gender, and individual variances in pain sensitivity, psychological aspects, emotional state, fear, hopelessness, coping strategies, sociocultural influences, social attitudes toward pain, noise levels,

lighting, prior experience with pain, concentration, distraction, and communication barriers brought on by intubation, sedation, or altered mental status. (Damico et al., 2020)

Unmanageable pain can result in longer mechanical ventilation, a prolongation in intensive care units (ICUs) length of stay, pulmonary problems, patient-ventilator asynchrony, and psychological trauma. Inappropriate treatment of pain can result in extended mechanical ventilation, cognitive impairment, psychosis, respiratory depression, and hemodynamic compromise. (Pota et al., 2022).

The simplest and most reliable method of assessing pain is subjectively using self-reported numeric scales, usually ranging from 0 to 10. This is the most widely used self-reported technique for pain assessments. A score of 0 indicates no pain, while a score of 10 indicates severe pain. However, the behavioral pain scale BPS and critical care pain observation Tool (CPOT) are the most reliable and effective behavioral pain scales for evaluating pain in adult intensive care units ICUs patients who are unable to self-report. (Georgiou et al., 2020)

Nurses have a critical role in recognizing and managing pain in critically ill patients. They are responsible for accurately evaluating pain levels using appropriate tools and techniques, taking into account the patient's medical condition and communication abilities, ensuring that their pain concerns are

effectively communicated to the healthcare team, collaborating closely with patients, families, and other healthcare professionals to address pain management needs and preferences, and implementing evidence-based pain management strategies to alleviate pain. (Hamdan., 2019).

Operational definition

Outcomes: Outcomes of these study (length of stay and mortality).

Significance of the study:

Pain is a prevalent complaint among patients in intensive care units (ICUs). (Nordness et al., 2021) More than 50% of patients feel discomfort during their ICU stay, resulting in poor sleep and traumatic memories for critically ill patients. Pain may also be an issue following ICU release, as one study indicated that 49% of ICU survivors reported discomfort at 3 months and 38% at 1 year. (Alves et al., 2023). Therefore, the current study tends to provide critical care nurses with insight into identifying the causes and outcomes of pain and then being aware of sufficient therapy to prevent adverse outcomes.

Aims of the study:

To assess the incidence and outcomes of pain in critically ill patients

Patients and Method

Research design:

A cross-sectional descriptive research design was used to conduct this study. This type of research aims to test pre-specified hypotheses or offer an overview of current conditions and perhaps relationships without modifying variables. (Anahita 2023).

Research question:

- Q1. What is the incidence of pain in critically ill patients?
- Q2. What are the outcomes associated with pain in critically ill patients?

Setting:

The study was conducted at several intensive care units at Sohag University hospitals (general intensive care unit, trauma intensive care unit, neuro-intensive care unit, coronary care unit, and respiratory care unit).

Sample:

A convenience sample of 344 critically ill patients admitted to critical care units during the period from October 2023 to March 2024 met the following criteria:

- Age ranged from 18 to 65.
- Recently admitted to critical care units.

Exclusion criteria

- Patient under sedation.
- Patient with disturbance conscious level.

Data Collection Tools:

Tool (I): A patient assessment tool: The researcher developed this tool after examining related literature to assess the studied patients regarding demographic, clinical data and pain assessment (Münzel et al., 2019; Downie et al. (1978); Dinse et al., 2022; Ito et al., 2022). That was divided into three parts. This tool included three parts:

Part (1): Demographic data: consists of patient's code, age, sex, and obesity.

Part (2) Medical data consists of three items: (past medical and surgical history and current diagnosis).

Part (3): Pain assessment sheet to assess intensity and causes of pain this part consists of the following:

1. **The numerical rating scale** was developed by Downie et al. (1978) and reused by Dinse et al. (2022). It is a subjective measure in which individuals rate their pain on an eleven-point numerical scale. Scoring system is composed of zero (no pain at all) to ten (the worst imaginable pain).
2. Causes of pain as tissue injury, secondary to invasive procedure, headache, positioning, etc.

Tool (II): patients' outcomes tool: This tool was developed by researchers after examining related literature to assess length of ICUs and mortality. (Sundrani et al., 2023)

Methods

1. The study began in September 2023, with a literature review, study idea, and tool construction lasting until October 2023.
2. Study tool were developed by the researcher based on national and international related literature
3. Content validity was done by three experts from the nursing and medical fields at Sohag University.
4. In the pilot study following tool creation, a pre-test was carried out on 10% of patients, which included 34 patients, to determine the reliability and accuracy of the research materials. Because the study tools did not undergo any substantial changes, patients from the pilot study were not enrolled in the main research study.
5. Reliability of these tools was assessed in a pilot study by measuring their internal consistency using Cronbach's alpha coefficient method (0.73). and inter-rater reliability of NRS in critically patient proved to be adequate (kappa =0.71) (Ahlers et al 2008)

Ethical considerations:

1. The nursing faculty's ethics committee at Assuit University approved the research proposal, Date (27/8/2023) , number (1120240662)
2. The research presented no harm to the study subjects.
3. The study followed ethical guidelines for clinical research.

4. Patients provided oral consent for participation in the study. After describing the nature and objective of the research.
5. Confidentiality and anonymity were guaranteed.
6. Study patients had the ability to decline or withdraw from the study without explanation at any time.
7. The privacy of study subjects was prioritized during data gathering.

Field work

Official permission to conduct the study was obtained from the dean of the faculty of medicine at Sohag University after an explanation of the aim and nature of the study. The researcher collected data daily for six months, from October 2023 to March 2024, from the time of admission to time of discharge. The presence and cause of pain were assessed by tool (1),

the part (3), three times per day. Then outcomes (ICU stay, mortality) were recorded as mentioned in Tool II.

Statistical analysis:

All data were recorded in a special chart for every patient. The collected data were coded, analyzed and tabulated. Data entry and analysis were done using SPSS 26.0 statistical software package. Data were presented using descriptive statistics in the form of frequencies and percentages for qualitative variables, and means and standard deviations for quantitative variables. Comparison between categorical variable utilized the chi-square, regression analysis and Pearson correlation coefficient (r) was used for correlation analysis. The degree of significance was identified at: $P > 0.05$ non-significant, $P < 0.05$ significant while $P < 0.01$ highly significant

Results:

Table (1): Percentage distribution of studied patients regarding their demographic characteristic (n=344)

Demographic characteristic	No.	%
Gender		
Male	198	57.6
Female	146	42.4
Age		
18 – 30	51	14.8
>30 – 40	52	15.1
>40 – 50	119	34.6
More than 50	122	35.5
Obesity (BMI)		
Less than 18.5	29	8.4
18.5 - 24.9	93	27.0
25 - 29.9	95	27.6
30 - 34.9	65	18.9
35 - 39.9	45	13.1
40 and more	17	4.9

Table (2): Percentage distribution of studied patients regarding past history and medical diagnosis (n=344)

Past history and medical diagnosis	No.	%
Past medical history		
No past history	88	25.1
Hypertension	168	48.0
Diabetes mellitus	123	35.1
Chronic obstructive pulmonary disease	28	8.0
Congestive heart failure	34	9.7
Valve disease	8	2.3
Pulmonary embolism	5	1.7
Liver disease	20	5.7
Chronic kidney disease	33	9.4
Myocardial infarction	7	2.0
Stroke	23	6.6
Surgical history		
	10	2.9

Past history and medical diagnosis	No.	%
Current Medical Diagnosis		
Respiratory failure	58	16.8
Coronary artery syndrome	42	12.2
Stroke	62	18.0
Shock	23	6.7
Hypertensive emergency	9	2.6
Trauma	44	12.7
Acute kidney injury	33	9.6
Heart failure	36	10.5
Diabetic ketoacidosis	17	4.9
Poisoning	6	1.7
Post-operative	15	4.4

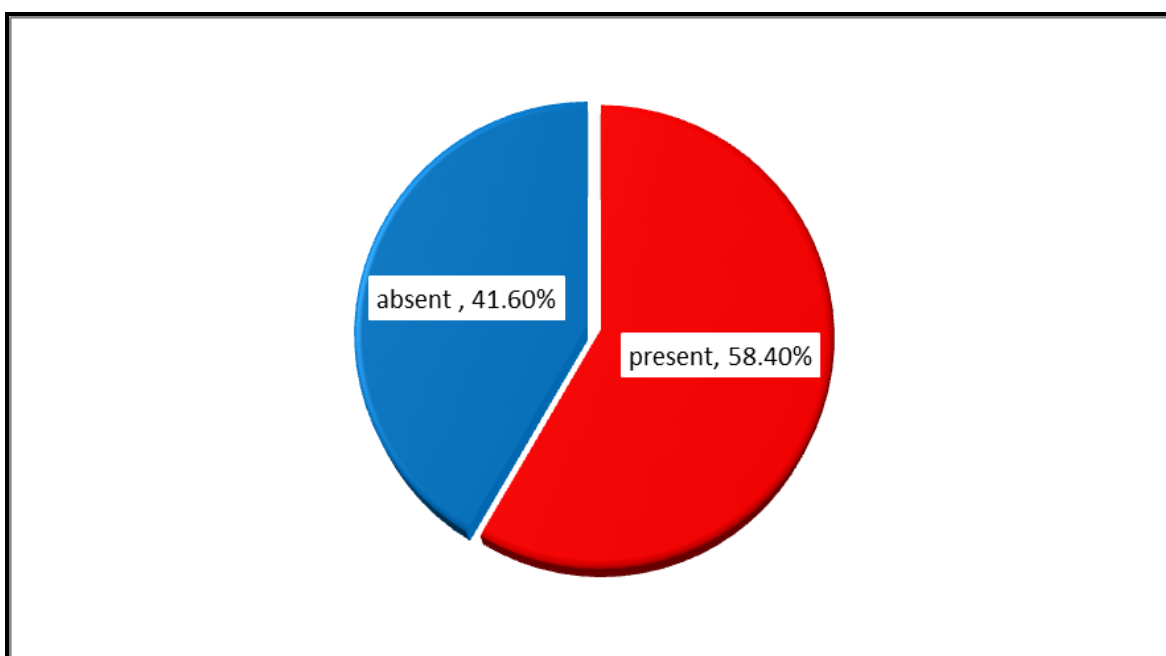


Figure (1): Frequency distribution of pain's incidence among the studied patients (n=344)

Table (3): Percentage distribution of studied patients according to causes of pain (344)

Causes of abnormal pain	No.	%
Causes of pain		
1- Tissue injury	63	18.3
2- Secondary to invasive procedure	94	27.3
3- Headache	39	11.3
4- Other	73	21.2
▪ Pulmonary Embolism	6	1.7
▪ Coronary artery disease	51	14.6
▪ Abdominal Pain	10	2.9
▪ positioning	6	1.7

Table (4): Relationship between pain and outcomes (n=344)

Items	Presence (n=201)		Absent (n=143)		X ²	P- value
	No.	%	No.	%		
Length of stay at critical care unit (LOS)						
1 day	30	14.9	35	24.5	X ² (20.112)	0.005**
2 days	34	16.9	30	21.0		
3 days	54	26.9	48	33.6		
4 days	48	23.9	16	11.2		
5 days	20	10.0	12	8.4		
6 days	10	5.0	2	1.4		
7 days	3	1.5	0	0.0		
8 days	2	1.0	0	0.0		
Mean and SD	3.23 ± 1.51		2.60±1.27		T(3.900)	0.000*
Mortality	15	7.5	11	7.7	X ² (0.006)	0.937

* Statistically significant difference (P-Value < 0.05).

Table (5): Pearson correlation between pain and outcome in studied patients

Outcomes	Pain	
	r.	p.
Length of stay at critical care unit	0.206	0.000**
Mortality	0.004	0.937 ns

* Statistically significant difference (P-Value < 0.05).

Table (1): Illustrates that the highest percentage of the studied patients is male (57.4%), ages over fifty (35.5 %) years old. Moreover, over one-quarter (26.6%) has a BMI in the range of 25 to 29.9.

Table (2): Shows that the most common medical histories are hypertension and diabetes mellitus (48.0 and 35.1% respectively). Also, respiratory failure, stroke, and Coronary artery syndrome are being the most common diagnose (16.8%, 18.0%, and 12.2%, respectively).

Figure (1): Illustrates that more than half of the studied patients (58.43%) in critical care units experience pain

Table (3): Delicate that the most common causes of pain among study subject were related to invasive procedures (27.3%) followed by tissue injury (18.3)

Table (4): Indicates that the mean length of stay (LOS) is higher among patient experience pain (3.23 ± 1.51) than not (2.60±1.27) with statistical significance difference. Also, mortality is higher among higher among patient experience pain.

Table (5): Describes the correlation between presence of pain and outcomes. It is founded that there is a highly significant relationship between pain and the LOS p value (0.000). But no relation present with morality.

Discussion

The discussion will cover the main result findings as follows:

Pain is a varied and complex problem among critically ill patients that can have serious consequences for their overall health and recovery.

They frequently experience pain as a result of a variety of reasons, including underlying medical disorders, invasive operations, posture, immobilization, and psychological distress. And many of them are unable to convey their pain properly, either owing to sedation, intubation, or a changed mental condition, which presents a particular problem in diagnosing and managing their pain. (Kim et al., 2020)

Regarding to age and gender, the present study patients showed that more than half of the studied patients were male, and more than a third of the studied patients had ages over fifty years old. This aligns with the results of (Georgiou et al. 2019), which assessed the impact of systematic pain assessment on the outcomes of critically ill patients and found that more than half study participants were male and older than fifty. Also, (Olsen et al.'s 2020) study titled (Pain in ICU Patients reported that the majority of their study subjects were male.

Regarding to obesity, the current study revealed that more than one-quarter were overweight, which was in line with the findings of the (Georgiou et al. 2019) study's title, (The effectiveness of systematic pain assessment on critically ill patient outcomes. And (Thikom 2020), who assessed the incidence of inadequate pain treatment among critically ill surgical patients, found that the bulk of their study sample were over weight

Regarding to past medical history, the current study revealed that the most common medical histories were hypertension and diabetes mellitus. Also, respiratory failure, stroke, and coronary artery

syndrome were the most common diagnoses. **Bourdiol et al. (2023)**, in their study about "prevalence and risk factors of significant persistent pain symptoms after critical care illness," found that the majority of the study sample had hypertension as a past medical history, while trauma and postoperative care were the causes of admission.

Regarding to the incidence of pain, the current study illustrated that the incidence of pain among the studied patients is greater than half, the researcher guesses increased incidence of pain in the present study could be attributed to differences in the study patients, such as cardiac, neurologic, or trauma surgery, the frequency of pain evaluation from the time of admission, and the types of procedures that cause pain

The finding in the present study is compatible with the findings of **Olsen et al. 2020**, who reported that more than half of patients experience pain during their ICU stay. Additionally, consistent with the result of **Aljumah et al. (2018)**, who evaluated the effect of assessment and management of pain in the intensive care unit, the more than two third of study subjects admitted to the intensive care unit with compliant pain. Moreover, the study "Pain in Intensive Care" by **Pota et al. (2022)** found that up to half of medical and surgical patients experience pain at some point during their stay in the intensive care unit (ICU).

But **Thikom (2020)**, who assessed the incidence of inadequate pain treatment among critically ill surgical patients, found that the incidence of pain among the studied patients was lower than that reported in the current study. Also, **Damico et al. (2020)** reported that the incidence of pain at rest and during nursing procedures was lower among ICU patients.

Regarding to causes of pain, the present study indicates that the most common causes of pain among study subjects were related to invasive procedures and tissue injury, the explanation of this finding is that the most common causes are secondary to invasive procedures because frequent arterial sample withdrawals are needed to monitor the prognosis of patient condition. Also the other most common causes for pain is tissue injury that is due to presence of patients with trauma , post-operative and a high percent of patients suffer from overweight and morbid obesity which make the patient more risk for bed sores which causing pain.

The finding in current study is compatible with the studies of **(Nordnesset al. 2021)**, who found that arterial line insertion, chest tube, drain removal, ventilatory support, tracheal tube suctioning, and changing position were the most common causes of pain for ICU survivors. **(Santos et al. 2019)** reported that the majority of the study patients experienced pain-related tracheal aspiration in an intensive care

unit. Moreover, **(Kalfon et al. 2020)**, who assess risk factors and events in the adult intensive care unit associated with pain as self-reported at the end of the intensive care unit stay, it was established that invasive procedures are the most common causes of pain among ICU patients.

Regarding to length of stay, the current study indicated that the studied patients experiencing pain had a higher mean length of stay (LOS), The researcher explains that poor pain self-reporting leads to incorrect pain control and psychological and physiological issues, resulting in an increase in length of stay (LOS) in this study.

The finding in the current study is consistent with that of **Kalfon et al. (2020)**, who assessed risk factors and events in the adult intensive care unit associated with pain as self-reported at the end of the intensive care unit stay. It was established that the study patients had the same mean of LOS. But it is not compatible with the findings of **the Alves et al. (2023)** study, which assessed the incidence and impact of pain in intensive care units through a systematic review that showed a significant reduction in the length of the ICU stay. Moreover, **Olsen et al. 2020** reported that the patients in their study had shorter ICU stays.

Regarding to the relationship between pain and length of stay, the current study shows that there is a highly significant relationship between pain and the length of stay. The researcher justifies that presence of pain affect most of body systems and to poor prognosis which subsequently increase LOS. This is not consistent with the findings of the **Thikom (2020)** study, which assessed the incidence of inadequate pain treatment among ventilated critically ill surgical patients and reported no statistically significant differences in the ICU lengths of stay. Also, **Damico et al. (2020)** reported that no relationship was detected between pain and ICU length of stay during the ICU stay.

Regarding to the relationship between pain and mortality, according to the current results, there is no significant relationship between intensity of pain and mortality rate. Additionally, **Damico et al. 2020** reported that no relationship was detected between pain and mortality during the ICU stay, which is not in agreement with the findings of the **Alves et al. (2023)** study, which assessed the incidence and impact of pain in intensive care units through a through a systematic review that reported a significant relationship with mortality rates.

Conclusion

According to the findings of the current study, the incidence of pain among critically ill patients in critical care units at Sohag University hospital was 58.43 percent. Furthermore, a substantial relationship

was shown between pain and LOS stay, but no relationship between pain and mortality.

Recommendations

- Scheduling pain evaluations every four hours using an appropriate scale.
- Nursing and medical schools should provide clinical and theoretical training on pain evaluation.
- Use "care bundle" to manage pain, agitation, and delirium.
- Provide appropriate local and/or parenteral anesthetic for any potentially painful procedures.
- Avoid unnecessary intrusive procedures that may cause pain.

Reference

- Ahlers, S., Gulik, V., van der Veen, A., van Dongen, H., Bruins, P., Belitser, S., de Boer, A., Tibboel, D., & Knibbe, C. (2008): Comparison of different pain scoring systems in critically ill patients in a general ICU. *Critical care (London, England)*, Vol 12, No (1).
- Aljumah, M., Aboshoushah, E., Coric, D., Alaithan, A., Almulhim, A., AlOtaibi, N., Alaslani, M., Kammas, F., AL Saeed, A. S., & Alharthi, A. (2018): Assessment and management of pain in the intensive care unit. *The Egyptian Journal of Hospital Medicine*, Vol 73, No (4), P.P 6439-6445.
- Anahita, G. (2023): An Overview of Quantitative Research Methods. *International journal of multidisciplinary research and analysis*. Vol (06), No(08)
- Alves, G., Bezerra, D., & Brito, B. (2023). Incidence and impacts of pain in intensive care units: systematic review. *Brjp*, 6(4), 435–447
- Bourdiol, A., Legros, V., Vardon-Bounes, F., Rimmelé, T., Abraham, P., Hoffmann, C., Dahyot-Fizelier, C., Jonas, M., Bouju, P., Cirenei, C., Launey, Y., Le Gac, G., Boubeche, S., Lamarche, E., Huet, O., Bezu, L., Darrieusecq, J., Szczot, M., Delbove, A., Schmitt, J., Lasocki, S., Auchabie, J., Petit, L., Kuhn-Bougouin, E., Asehnoune, K., Ingles, H., Roquily, A., & Cinotti, R. (2023): Prevalence and risk factors of significant persistent pain symptoms after critical care illness: a prospective multicentric study. *Critical care (London, England)*, Vol(27), No (1), 199.
- Damico, V., Macchi, G., Murano, L., & Forastieri Molinari, A. (2020): Incidence of pain at rest and during nursing procedures in ICU patients: a longitudinal observational study. *Annali di igiene: medicina preventiva e di comunita*, Vol 32, No (4), P.P 407–418.

- Dinse, C., Bucher, M., Burgdorff, A. M., Christel, A., & Flöther, L. (2022): Pain management in surgical intensive care patients: A retrospective observational research. *Medicine*, Vol 101, No (46), P.P e31297.
- Downie, W., Leatham, P., Rhind, V., Wright, V., Branco, J., & Anderson, J. (1978): Studies with pain rating scales. *Annals of the rheumatic diseases*. Vol (37). P.P 378–381.
- Emsden, C., Schäfer, U., Denhaerynck, K., Grossmann, F., Frei, I., & Kirsch, (2020) Validating a pain assessment tool in heterogeneous ICU patients: Is it possible? *Nursing in critical care*, Vol 25, No (1): P.P 8-15.
- Georgiou, E., Paikousis, L., Lambrinou, E., Merkouris, A., & Papathanassoglou, E. (2020): The effectiveness of systematic pain assessment on critically ill patient outcomes: A randomised controlled trial. *Australian critical care : official journal of the Confederation of Australian Critical Care Nurses*, Vol 33, No (5), P.P 412–419.
- Hamdan K. (2019): Nurses' Assessment Practices of Pain Among Critically Ill Patients. *Pain management nursing: official journal of the American Society of Pain Management Nurses*, Vol 20, No (5), P.P 489–496.:
- Ito, Y., Teruya, K., & Nakajima, E. (2022): Evaluation of pain severity in critically ill patients on mechanical ventilation. *Intensive & critical care nursing*, Vol 68, 103118.
- Kalfon, P., Boucekine, M., Estagnasie, P., Geantot, M., Berric, A., Simon, G., Floccard, B., Signouret, T., Fromentin, M., Nyunga, M., Audibert, J., Ben Salah, A., Mauchien, B., Sossou, A., Venot, M., Robert, R., Follin, A., Renault, A., Garrouste-Orgeas, M., Collange, O., & IPREA Study Group (2020): Risk factors and events in the adult intensive care unit associated with pain as self-reported at the end of the intensive care unit stay. *Critical care (London, England)*, Vol 24, No (1), 685.
- Kim, T., Kim, J., Choi, E., Chang, Y., Choi, W. I., Hwang, J. & Cho, J. (2020): Utilization of pain and sedation therapy on noninvasive mechanical ventilation in Korean intensive care units: a multi-center prospective observational study. *Acute and Critical Care*, Vol 35, No (4), p.p 255-262.
- López-López, C., Arranz-Esteban, A., Arias-Rivera, S., Solís-Muñoz, M., Pérez-Pérez, T., & Latorre-Marco, I. (2020): Application of the Behavioural Indicators of Pain Scale in patients with traumatic brain injury. *Journal of Advanced Nursing*, Vol (76), No (7), P.P 1862-1870.
- Münzel, T., Hahad, O., Gori, T., Hollmann S, Arnold N, Prochaska J H., Schulz A, Beute IM, Pfeiffer N, Schmidtman I, Lackner K J.,

- Keaney J. & Wild P S (2019):** Heart rate, mortality, and the relation with clinical and subclinical cardiovascular diseases: results from the Gutenberg Health Study. *Clin Res Cardiol* **108**, 1313–1323
- **Nordness, M., Hayhurst, C., & Pandharipande, P. (2021):** Current Perspectives on the Assessment and Management of Pain in the Intensive Care Unit. *Journal of pain research*, Vol (14), P.P 1733–1744.
 - **Olsen, B., Valeberg, B., Jacobsen, M., Småstuen, M., Puntillo, K., & Rustøen, T. (2020):** Pain in intensive care unit patients-A longitudinal study. *Nursing open*, Vol (8), No (1), P.P 224–231.
 - **Pota, V., Coppolino, F., Barbarisi, A., Passavanti, M. B., Aurilio, C., Sansone, P., & Pace, M. (2022):** Pain in Intensive Care: A Narrative Review. *Pain and therapy*, Vol 11, No (2), P.P 359–367.
 - **Santos Oliveira L, Pimentel Macedo M, Silva S, Oliveira AP, & Santos V (2019).** Pain assessment in critical patients using the Behavioral Pain Scale. *BrJP.*; Vol 2, No (2), P.P 112-6.
 - **Sundrani, S., Chen, J., Jin, B.T. Abad Z S H, Rajpurkar P & Kim D (2023):** Predicting patient decompensation from continuous physiologic monitoring in the emergency department. *npj Digit. Med.* **6**, 60
 - **Thikom N, Thongsri R, Wongcharoenkit P, Khruamingmongkhon P, & Wongtangman K. (2021):** Incidence of inadequate pain treatment among ventilated, critically ill surgical patients in a Thai population. *Pain Manag Nurs.*; Vol 22, No (3): P.P 336-42.

This is an open access article under
[Creative Commons by Attribution Non-Commercial \(CC BY-NC 3.0\)](https://creativecommons.org/licenses/by-nc/3.0/)
(<https://creativecommons.org/licenses/by-nc/3.0/>)