Arab American University

Faculty of Graduate Studies

Critical-care pain observation tool versus behavioral pain assessment tool for pain evaluation in mechanically ventilated adult patients: an experimental quasi study

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This thesis was submitted in partial fulfilment of the requirements for the Master's degree in emergency nursing

October/2022

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DECLARATION

I, Ziad Daraghma, hereby certify that the work included in this thesis is both unique to me and the product of my own original study. The difficulties that the measurement of pain sometimes could be difficult and need for well trained nurse, the work presented in this thesis has not been previously submitted for any other degree or qualifications, thus some difficulty in addressing steps and the flow of research process.

Student’s name : Ziad Daraghma

Signature:

Date :

Dedication

I dedicate my work to my family (My Mother, Father, Sisters, and Brothers) who support me over the last year in my journey to a master degree. Also, I dedicate my work for all people participated in this study.

Acknowledgement

First of all, I am very grateful to **ALLAH** almighty for blessing me much more than I deserve. I place on record, my sincere thanks to **Dr. Najwa Mohammad Soboh**, for suggesting the point of research, meticulous supervision, help in writing and sparing his time during the preparation and revision of every part of this work. Special deep appreciation to **Dr. Ahmad Aydeh** for his precious help.

I would like to thank **Dr. Mohammad Jallad** for guidance, valuable advice, and continuous encouragement.

I also place on record, my sense of gratitude to **one and all, who directly or indirectly**, have lent their hand in this venture.

Last but not least; I would like to give my warmest appreciation to **My Family** for supporting me spiritually throughout my life.

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List of Abbreviations

Symbol	Abbreviation
A/C	Assist-Control
ARDS	Acute Respiratory Distress Syndrome
BiPAP	Bi-Level Positively Airways Pressure
BPS	Behavioral Pain Scale
CFS	The Clinical Frailty Scale
CPAP	Positive Airway Positive Airway Pressure
CPOT	Critical-Care Pain Observation Tool
DCD	Donating After Circulatory Death
ECMO	Extracorporeal Membrane Oxygenation
EPAP	Expiratory Positively Airway Pressures
FACS	Facial Action Coding System
GCS	Glasgow Coma Scale
HFNC	High Flow Nasal Cannula
IBW	Ideally Body Weight
ICU	Intensive Care Unit
ICUAW	Intensive Care Unit Acquired Weakening
I/E	Inspiratory/Expiratory
IMV	Intermittent Mechanical Ventilation
NIPPV	Noninvasive Positive Pressure Ventilation
PaCO2	Partial Pressure Of Carbon Dioxide

PAD	Pain, Agitation, Delirium
PCV	Pressure Controlling Ventilations
PEEP	Positively End Expiratory Pressure
PSV	Pressure Supporting Ventilations
PTSD	Posttraumatic Stress Disorder
RaCI	Rehabilitation After Severe Illness
SIMV	Synchronized Intermittent Mandatory Ventilations
SIRS	Systemic Inflammation Reaction Syndromes
VALI	Ventilator-Associated Lung Injury
V/C	Volume-Controlling

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Abstract

Background: Critically ill patients frequently experience both procedural pain and pain at rest. Chest tube removal, tracheal suctioning, wound care, turning and arterial line insertion have been shown to be the most painful procedures Pain assessment in unconscious patients is a major challenge for healthcare providers. This study aims to compare the diagnostic value of the critical-care pain observation tool (CPOT) and the behavioral pain scale (BPS) for pain assessment among unconscious patients.

Materials and methods: A descriptive, prospective, cross-sectional study design to compare of the BPS and CPOT scale in detecting patient's pain pre-during & post invasive procedures of ICU & Comparison of pain intensity in invasive procedures at Jenin & Rafidea Hospitals. Thirty patients were admitted to the ICUs of Rafedia Governmental & Jenin Hospitals in North West Bank during 3 months.

Results: correlation test was performed between both BPS and CPOT after pain procedures. The analysis revealed that the BBS and CPOT were strongly correlated in applied cannula, Secretion suctioning, changing position, and Needle stick procedures (0.838, 0.838, 0.987, and 0.968) at $p < 0.001$ respectively. **Conclusion:** Both scales are

adequate for assessing pain in orotracheally intubated patients admitted to intensive care units.

Keywords: Pain; Critical illness; Critical care; Behavioral Pain Scale; Critical Care Pain Observation Tool; Pain measurement.

Chapter One

Introduction

Pain is defined by the International Association for the Study of Pain (IASP) as "an unpleasant sensory and emotional experience associated with or resembling that associated with, actual or potential tissue damage" (***Williams and Craig, 2016***). Patients in intensive care units (ICU) feel pain and require analgesia whether they can tell those caring for them or not, and the inability to speak verbally does not negate the likelihood that a person is in pain and requires appropriate pain relieving treatment (***Treede, 2018***). The definition emphasizes the subjective nature of pain and suggests that its intensity can be assessed only by someone experiencing it. It is obvious that many patients treated in intensive care units (ICUs), particularly those intubated and mechanically ventilated, do not fit this definition as they cannot self-report pain sensations or assess their intensity. The assessment of pain in ICU patients is a daily challenge for therapeutic teams, especially in patients who are endotracheally intubated, mechanically ventilated or analgosedated. Additional difficulties are co-existing neurological and mental disorders (e.g. aphasia, dementia, critical condition-related delirium, psychoses) (***Kotfis et al., 2017)***.

More than 70% of ICU patients have unrecognized pain, and more than 50% have significant pain during procedures or routine care (Issa ***et al., 2017; Kotfis et al., 2017***). Uncontrolled pain causes physical and emotional stress responses, inhibits healing, increases the risk of various complications, and lengthens stay in the critical care unit (***Kotfis et al., 2017***). Furthermore, severe pain impairs a patient's recovery and discharge by interfering with cardiovascular and respiratory function. Pain, along with anxiety, depression, and posttraumatic stress disorder (PTSD), can all contribute to poor psychological outcomes in ICU patients. As a result, it is crucial for nurses to assess a patient's pain profile, and pain medication should be chosen based on individual needs and the desired analgesic effect (***Gelinas & Puntillo, 2018***).

Effective pain assessment is paramount in all patients, particularly critically ill patients. Critically ill patients are much more vulnerable to the side effects of untreated pain, and ineffective assessment of pain is associated with negative patient outcomes ***(Gélinas, 2016).*** Observational pain scales, such as the Behavioral Pain Scale (BPS) and Critical Care Pain Observation tool (CPOT) are tools used to measure pain in the ventilated nonverbal patient and are used to better assess pain

Pain often goes unrecognized due to inadequate assessment, and as a result pain is often poorly managed. Pain assessment is further complicated in the absence of verbal communication, and such is the case in the mechanically ventilated critically ill patient. Observational pain scales such as the BPS and CPOT offer an assessment tool to assess pain in the nonverbal patient so pain can be treated more effectively ***(Gélinas, 2016).***

Raja et al, 2020 reported that critically ill patients admitted to the intensive care unit (ICU) are subjected to numerous painful procedures, and approximately 75% report severe pain, 30% report pain at rest, and 50% report pain during nursing procedures. Due to the difficulty of assessing and controlling pain, it is often neglected, compromising patient recovery and well-being. The accurate assessment of pain contributes to effective care management; improved adequacy of therapeutic measures, including analgesic and sedative use; and shorter IMV durations and lengths of stay in the ICU. (***de Saúde & Portugues, (2019).*** Pain control is a patient right and a duty of health care professionals, and the negation and devaluation of pain are ethical errors and failures of excellence in professional practice.

Thus, when patients cannot self-report pain, health care professionals must resort to the use of validated pain assessment scales, such as the Behavioral Pain Scale (BPS), which assesses indicators such as facial expression, upper limb movements and compliance with ventilation, and the Critical Care Pain Observation Tool (CPOT), (***Kotfis et al., 2017***) which assesses indicators such as facial expression, body movements, muscle tension and compliance with ventilation in intubated patients or vocalization in extubated patients . These two observational and behavioral scales are indicated for the assessment of pain in critically ill patients who are sedated and/or unconscious and undergoing IMV and/or have difficulty with self-reporting pain. (***Kawagoe et al., 2017***)

Untreated acute pain in adult ICU patients can lead to short- and long-term physiological and psychological complications such as postoperative myocardial infarction, insufficient sleep and posttraumatic stress disorder (***Rijkenberg et al., 2016***). Practice guidelines recommend an individualized and goal directed pain management.

A ventilator is a life support system designed to replace or support normal respiratory function. The main purpose of providing mechanical ventilator support is to restore the normal function of air exchange and improve respiratory function back to normal1 while according to Muslika mechanical ventilation or ventilator is a breathing device with negative or positive pressure that can maintain ventilation and giving oxygen for a long time. The criteria for ventilator installation are: Frequency> 35 x / minute, PaO2 60 mmHg, AaDO2 with 100% O2> 350 mmHg, and vital capacity **(*Idris et al., 2021).***

Patients with a ventilator need to be assessed for pain because of the patient's inability to convey pain verbally. The pain experienced by a patient on a ventilator is not only due to the disease but also because of the installation of a device, one of which is the installation of an endotracheal tube and the installation of a mechanical ventilator causing injury to the larynx and causing pain (***Craig et al., 2018)***. Based on the journal Bastia, which was obtained from interviews with critical patients who were put on a ventilator, they had physical, psychosocial, and spiritual problems and patients who were put on a ventilator would feel pain and discomfort caused by endotracheal and some devices installed in the patient's body felt helpless (***Olsen et al., 2021)***. Pain in a patient on a ventilator can cause psychological and physiological changes. The psychological changes shown by patients who were put on a ventilator during the assessment included grimacing, stiff facial expressions, closed eyes, and the expression of clenched hands (***Suwardianto & Sari, 2019).***

Assessing pain on this scale becomes difficult to do when patients are ventilated and unable to self-report pain. When self-reporting is not possible, observational tools including the BPS and the CPOT have been verified to evaluate pain in critical care settings (***Gélinas, 2016***). The BPS provides a pain scale that is based on facial expressions, upper limb movement, and compliance with ventilation (***Kotfis et al., 2018)***. The CPOT is similar, but it uses four different categories to assess pain including: facial expressions, body movements, muscle tension, and compliance with the ventilator. Though observational pain scales have been established, there have not been repeated comparison studies between the BPS and the CPOT to evaluate if one scale is superior to the other or if both indicate comparable pain assessment simultaneously. Nurses' evaluation of the feasibility, clinical relevance, and satisfaction of the tools is also an area for further evaluation (***Bardwell et al., 2020)***.

1.1. Conceptual Variable Definitions

Critical care nurse: A licensed professional nurse who has the responsibility to ensure and safeguard the assessment, care, and delivery of care to an acutely and critically ill patient.

Critical care patient: A patient that is acutely or critically ill and at high risk for the potential for or currently experiencing actual life-threatening health conditions and requires more attentive and advance nursing care ***(Gélinas, 2016***).

Pain: A neurological process brought on by discomfort, illness and injury or suffering that can be exacerbated or diminished by mental, emotional, and behavioral components and can become further complicated by cultural, social, and situational circumstances (***Hadjistavropoulos et al., 2011***).

1.2. Operational Variable Definitions

Patients' pain level: Pain was measured utilizing the scores of the BPS and CPOT. The BPS measures pain and provides a numerical score of 1 to 4 for the area of facial expressions, upper limb movement, and compliance with ventilation for a total score of 3 to 12.

The CPOT measures the areas of facial expressions, body movements, muscle tension, and compliance with the ventilator with a possible score of 0 to 2 in each area for a possible total score ranging from 0 to 8 (***Gélinas, Tousignant-Laflamme, Tanguay, & Bourgault, 2011).***

1.3. The hypotheses of the study will be

The hypotheses of the study will be

H1: There is a significant association between COPT scale and effective measurement of pain patients admitted in ICU at P<0.05

H2: There is a significant difference between BPS scale and effective measurement of pain patients admitted in ICU at P<0.05

H3: There is a significance difference in the accuracy measurement of pain in using COPT as a tool for pain assessment

1.4. Questions

1) What is the relationship between the Behavioral Pain Scale and the Critical-Care Pain Observation Tool in assessing pain in ventilated critical care patients?

Chapter Two

Review of Literature

2.1. Critical care

The method of providing care that either have life-threatening diseases or are at danger of getting them is known as critical care. High personnel levels, sophisticated management, and organs supports can be provided in the intensive care unit (ICU), a separate geographic area, to reduce patient morbidity and death ***(Rijkenberg et al., 2017***). Furthermore, providing efficient intensive care necessitates a comprehensive strategy that goes beyond the ICU. Before and during an ICU admission, preventive, early warning and response systems, a multimodal team, thorough follow-up, and high-quality palliative care are all necessary (***Kotfis et al., 2017***).

The improvement of a patient's physiology, the supply of improved organs supports, and the detection and treatments of fundamental pathological conditions are the fundamentals of intensive care administration (***Khanna et al., 2018***). A multidisciplinary team strategy is the most effective way to accomplish this, with shared accountability between the admission staff, or "parents," and a specialist intensive care staff, which is led by a critical care specialist (***Faritous et al., 2016***).

2.2. Organization of critical care facilities

2.2.1. Prevention and ‘critical care without walls’

Although it is difficult to identify acutely un-well people in hospitals, doing so may produce positive outcomes. Early detection scoring and "track and trigger" mechanisms are now being used in several nations (***Severgnini et al., 2016***). To prevent any worsening and lessen necessity eventual intensive care hospitalization, quick ward care efficiency and earlier leadership engagement are crucial. Teams that provide medical emergency and critical care may be crucial in promoting earlier, proactive ward care and also aiding in the training and development of knowledgeable staff members (***Marra et al., 2017***).

2.2.2. Referral and admission to the ICU

It takes leadership input from the parent's specialty and a critical care specialist to decide whether to admit patients who is rapidly deteriorating to the Intensive care unit. The main concern is whether the patient's interests will be served by admittance to an Intensive care unit and an increase in treatment (***Johnson et al., 2016***). Although a lot of work has gone into developing rating systems that can forecast particular factor on patient's condition, physiological characteristics before admittance, age, and comorbidity, they may not always apply to specific individuals or be meaningful in an emergency context. Patient fragility is a word that is frequently used since it may have a significant impact on how well a patient will do in an intensive care unit. The evaluation of frailty may provide crucial information that may aid in making decisions during the perioperative process (***Ronco et al., 2017***).

The Clinical Frailty Scale (CFS), which provides a rating between 1 and 9 corresponding to the patient's pre-morbid activities and reliance degrees, is one instrument that can be used to swiftly assess frailty (***Alharbi, Jackson, & Usher, 2020b***). A significant scoring has been linked to higher postoperative mortality rates. The CFS must be used care in individuals under the age of 65 because it has not been established in this age range. The CFS is not intended for usage by people with learning disabilities or stable long-term disabilities (***Sole, Klein, & Moseley, 2020***).

The aforementioned concerns must be taken into account for each emergent referral:

- Is there a clinical manifestation that can be reversed?
- Would the patients possess the physiological stamina to bear the stresses of their condition and the required care?
- Does the sufferer believe there is a reasonable likelihood of rehabilitation and a recovery to an adequate standard of living?
- Have the patients voiced any preferences for their treatment? Do they have an instruction from the future?

Any admittance must achieve a balance between the professional Intensive care unit treatments that are accessible and the ability to significantly disturb the patients, with effects on their physical and mental health both during and after their hospitalization in the ICU (***Johnson et al., 2016)***. Consideration must be given to the underlying moral tensions between benevolence (opportunity of a positive outcome), non-maleficence (ICU treatments frequently necessitate distressing or painful side effects), autonomy (patients commonly lack the freedom to articulate their desires), and fairness (responsibility with regard to resource allocation). These variables are intricate and should be taken into account for each patient individually, carefully, and with knowledge (***Urden, Stacy, & Lough, 2017***).

There are two main categories of critical care hospitalizations:

- Planned admissions: Patients who need to have their physiological conditions optimized and monitored before or typically after a treatment, such as high-risk major generalized surgery patients who need post - operative services to watch for medical complications, anaesthetic side effects, or the escalation of recognized comorbidities (***Subramanian et al., 2020***).

- Emergency admissions: Patients with organ dysfunction who need observation and care for one or more important organ functions, such as those who have septic shock due to peritonitis in the fourth quadrant and needed invasive breathing and post-operative hemodynamic care (***Vergano et al., 2020***).

In general, critically caring surgical patients tend to experience reduced acute hospital death than hospitalized personnel. According to recent UK statistics, this was expected to be 2.4% for planned surgery, 13.6% for immediate surgery, and 27% for non-surgical individuals ***(Wax & Christian, 2020).***

2.3. Levels of caring

A wide range of cutting-edge surveillance and organs supporting options are available in contemporary critical care treatment (***Heath et al., 2020)*** (Table 1).

Table (1): Outline of several strategies for detecting and supporting critical care organs (Heath et al., 2020).

Organ system	**Common on ICU**	**Available in specialized units**
Respiratory	Treatment using high-flow nasal cannulas and oxygen CPAP (nasal, hood, mask) invasive-free airflow Nonessential ventilating (various techniques including recruitment manoeuvres) invasive tracheostomy BAL (bronchoalveolar lavage) and bronchoscopy ventilator susceptible	Elimination of extracorporeal CO2 (ECCO2R) Oscillatory ventilation Extracorporeal membrane oxygenation (ECMO)
Cardiovascular	Administration of Intravenous fluid Inotropes and vasopressors Peripheral arterial and venous catheter Cardiac output controlling: Oesophagealdoppler, arterial blood floating catheters and pulse shape assessment (LiDCO, PiCCO, and others). Heart pumping Echocardiogram (trans-thoracic and trans esophageal)	Ventricles assistance systems with an intra-aortic ballooning counter pulsation pumping
Renal	Kidney replacement therapies, such as periodic hemodialysis or continual veno-venous filtering	
CNS	neurologic findings Observation of unprocessed EEG (or EEG-derived) surveillance of intraocular pressure Temperature control and medicinal freezing	Venous jugular oximetry Doppler scan of the brain Microdialysis of the brain surveillance of the oxygen delivery of brain tissue
Gastrointestinal	Immune-stimulating nourishment, enteral and intravenous feeding surveillance of intra-abdominal pressures	hepatic insufficiency and the molecules adsorbent recirculation systems (MARS)
Others	Intrathecal and epidural analgesics transfer of plasma neuromuscular surveillance	

These rely on the layout and range of each item ***(Liu, Li, & Feng, 2020)***. Two vital treatment categories are outlined below:

High-dependency unit (HDU) or ‘level 2’: Single-organ support admissions (excluding invasive ventilation) shouldn't necessitate a specialist intensive care nursing for every patient ***(Arabi, Fowler, & Hayden, 2020):***

- respiratory: non-invasive ventilation, arterial blood gases

- cardiovascular: low dose vasopressors, invasive arterial pressure monitoring
- Renal: close fluid balance control, certain renal replacement therapies.
- Intensive care unit (ICU) or 'level 3' (***Phua et al., 2020***):

Advanced tracking methods or admittance for multi-organ care necessitate at least one patient-specific intensive care nurse (***Conway & Wong, 2020***):

- Respiratory: invasive and non-invasive ventilation, extra-corporeal membrane oxygenation (ECMO) or carbon dioxide removal (ECCO2R) in selected centers.
- Cardiovascular: vasopressor and inotropic support advanced cardiac output monitoring, intra-aortic balloon pump, ventricular assist devices, ECMO renal: renal replacement therapies.
- neurological: intracranial pressure monitoring, EEG, advanced neurological monitoring (***Leisman et al., 2020)***.

2.3.1. Post critical care

The critically caring staff continues to be involved even after an ICU patient is discharged, and several departments are building procedures to guarantee excellent in-patient follow-up, with some facilities even setting up RaCI (Rehabilitation after Severe Illness) clinics. These could aid in comprehending, reducing, and preventing the negative long-term impacts of serious disease. It is only lately that the long-term burden and decline in quality of life post-critical disease are being recognized, despite more individuals survived until hospitalization discharging ***(Dennis et al., 2021)***.

2.3.2. Sepsis

A significant majority of ICU patients either develop sepsis at the time of admission or as a consequence while they are in the ICU due to septic, which is a significant cause of morbidity and mortality worldwide. "Life-threatening organ failure induced by a down regulation host response to infections" is how sepsis is characterized (***Sole et al., 2020***) (Table 2).Sepsis exacerbated by hypertension in spite of volume therapy and elevated blood lactate >2 mmol/L is known as sepsis. It is important to note that the systemic inflammation reaction syndromes (SIRS) is generally used to describe sepsis because it may actually represent a necessary reaction to infections, inflammatory processes, or a mixture of the two (Messmer et al., 2020).

Table (2): Commonly used descriptions of sepsis (Bajwa, Sarna, Bawa, & Mehdiratta, 2020)

Condition	**Definition**
Sepsis	'down regulation host responses to infections leading to life-threatening organ failure'
Septic shock	the subsequent clinical elements • Hypotension (MAP <65) • C Vasopressor requirement despite fluid resuscitation • Raised lactate above 2 mmol/L

Septic survivor rates have significantly increased in the industrialized countries over the last ten years. This has been linked to the fact that the fundamental concepts of sepsis have gained widespread acceptance, thanks in part to international campaigns like the Survival Septic Campaign (***García-Salido et al., 2020***).

The fundamental tenets of increasing septic treatment are:

- Quick detection of sepsis
- A balanced approach to rehabilitation.
- Prompt detection of the infection's origin
- Prompt sources identification; early and efficient antibiotic treatment
- Support for hemodynamics, thought of additional treatments, and excellent supportive therapy (***Reddy et al., 2020)***.

2.3.3. Critical care organ support

The incorporation of complicated information and a systems-based strategy are typically necessary for providing high quality care for critically ill patients. Several treatments have been bundled into "care bundles" to provide a continuously high quality of care, and research has shown that doing so improves outcomes ***(Gomez et al., 2020).***

2.3.4. Airway and respiratory support

Many severely ill patients who require some kind of sophisticated respiratory support while they are being admitted. It is important to remember that starting mechanical breathing could result in severe patient morbidity. On the other hand, it shouldn't be put off until the sufferer is in critical condition (***Kerlin, McPeake, & Mikkelsen, 2020***). Technological treatments, therefore, cannot take the place of high-quality basic respiratory therapy, which frequently includes contributions from a number of specializations, most importantly the physiotherapist (***Malbrain et al., 2020)***.

High flow oxygen therapy: is currently often utilized in the ICU, for separate systems ward-based assistance during surgery, and for patients undergoing surgical. A nasal or facial connection is being used to provide extremely high volumes of warmed, humidification oxygen to sufferers at a predetermined oxygen percent ***(Wei et al., 2020).*** By generating a tiny amount of positively end expiratory pressure (PEEP) and flushing away dead space gases, large flows of up to Sixty liters/min are believed to minimize respiratory function and enhance respiratory biomechanics. This helps tolerability, enhances secretions clearing, and prevents the mucous membranes from drying up when combined with humidifying (***S. Liu et al., 2020***). In compared to non-invasive breathing or facial masks oxygenation, high flow nasal cannula (HFNC) has been proven to be helpful in the therapy of individuals with symptomatic severe hypoxia respiratory distress (***Rungta et al., 2020***).

Non-invasive ventilation (NIV): is a type of breathing assistance that does not require tracheal intubation. Positively airway pressure is often frequently applied through a facial connection using either continuous positive airway positive airway pressure (CPAP) or bi-level positive airway pressure (BiPAP) (***Kleinpell et al., 2020***).

The term "CPAP" stands for continuous positively airway pressures during the breathing cycle. This is comparable to PEEP in patients receiving invasive ventilation. The advantages provide a decrease in the breathing rate, the rectification of lung shunt, the restoration of hypoxia through alveolar recruiting, and a decrease in heart afterload (via illuminated left ventricular transmutably pressures). Whether it’s a snug-fitting face masks or a specific CPAP hood or helmet are used to administer CPAP. Pressure injury must be avoided at all costs, especially to the nasal bridges (***McGain et al., 2020***).

Bi-level positively airways pressure (BiPAP) enables distinct breathing adjustments for the breathing cycle's inspiratory (IPAP) and expiratory (EPAP) phases. The advantages of CPAP are maintained, but the participant's tidal volume is increased, and respiratory muscles insufficiency is overcame. The most popular way to deliver NIV BiPAP is using snug facemasks (***Arulkumaran et al., 2020***).

NIV administration is effective when the patient cooperates and there are no restrictions, such as an uncovered airways, an obstruction to secretions clearance, significant hemodynamic instability, or the existence of an uncontrolled pneumothorax (***Alharbi, Jackson, & Usher, 2020a)***.

The use of NIV in the management of chronic insufficiency brought on by COPD and sinus tachycardia pulmonary edema is well recognized. Nevertheless, it is now effectively utilized in the treatment of asthma and bronchitis (***De Biasio et al., 2020***), as a treatment for postoperatively respiratory failure, other types of pulmonary disease, and as a tool to help patients wean off mechanical ventilation **(*Webb, Angus, Finfer, & Gattioni, 2020*).**

Owing to the danger of operative emphysema related with the application of positive pressure, a surgeon assessment might well be asked before starting NIV in individuals who have recently undergone upper GI or head and neck operations or those who have pathology in these regions. In these circumstances, it is important to carefully weigh the risks of respiratory or operatively consequences ***(Harhay et al., 2020).***

Airway intubation is required for invasive breathing in one way or another. Compared with control setting of an optional theatre lists, maintaining the airways in severely sick patients presents considerable extra complications (***Vranas et al., 2020)***. This may be caused by severe physiological disturbances (frequently accompanied by a steep decline), the existence of morphological challenges (such as airway burn injuries), outside variables (such as cervical in-line stabilization in trauma), intense time constraints, less-than-ideal positional awareness, unknown surroundings, and a lack of facilities and assistance. Therefore, for patient safety, careful planning and appropriate communications of airways strategies are essential (***Fink et al., 2020)***. Some indications for tracheal intubation are outlined in Table 3.

Table (3): Reasons to intubate the trachea (Teece, Baker, & Smith, 2020)

Purpose	Examples
Guarantee upper patent airway	Respiratory obstructions that is present or predicted, such as a tumor, infections, trauma, decrease of or pharyngeal tissues tone, or inhaling damage
Defend the lower airways (against aspiration and soiling)	Reflexing loss in the airways: poor GCS, bulbar insufficiency, etc.
Make sure there is enough airflow and oxygenation.	either hypoxia or hypercapnic pulmonary insufficiency optimize utilization and distribution of oxygenation (e.g. sepsis) the management of cerebral blood flow
promote action and removal of secretions	Respiratory aspiration Bronchoscopy/lavage

Several intensive care units in the UK employ mechanically ventilation systems, which are becoming more complex and offer a wide range of options depending on the patient's fundamental physiology and acute pathologies. The most sophisticated equipment can automatically adapt while keeping track of the patient's breathing mechanics to maximize ventilation (***Kanter, Segal, & Groeneveld, 2020)***.

In general, patients who has been endotracheal intubation may be totally ventilated by the device, may initiate breathing on their own, or a mixture of the two. Weaning is the procedure of lowering the ventilator's level of support so that the patients can be securely extubated ***(Al Ma'mari, Sharour, & Al Omari, 2020)***. It is important to take note of a patient's oxygen needs (FiO_2), as to if or not they are respiration on their own, and basic features like the quantity of PEEP they need when evaluating an intubated patients (***Li et al., 2020***).

Susceptible ventilation, extracorporeal carbon dioxide removals, and ECMO are examples of enhanced breathing assistance treatments. Prone ventilations can improve mortality in patients with severe acute respiratory distress syndrome (ARDS) (G***riffin, Liu, & Teixeira, 2020***).

The repeated growth and inflation of collapsing lungs regions (atelectotrauma), as well as the induction of pro-inflammatory cytokines, are all ways that ventilation system can cause lungs damage. These mechanisms are most likely responsible for barotrauma and volutrauma (biotrauma). Currently commonly used in clinical practice, a lung-protective ventilated technique has been developed from ventilatory care in ARDS (***Gutierrez et al., 2020)***. It comprises the following ventilator objectives:

- An objective for 6 to 8 ml/kg of tidal volume (of ideal body weight).
- Keep plateau pressure to ≤30 cmH_2O or less.
- Use PEEP of at least≥ 5 cmH_2O to prevent alveolar collapses (**Duncan et al., 2020)**.

Cardiovascular destabilization, ventilator-associated pulmonary fibrosis or pneumonitis, oxidation toxic effects, and problems from protracted immobilization and sedative use in the critical care unit are all complications of mechanical ventilation. Laryngeal intubation-related problems include harm to lips, teeth, and vocal cords. Equipment-related issues include ventilator malfunction or contamination (***Wong et al., 2020)***. A "ventilator care package" including the following elements has been developed to minimize the chance and intensity of these problems (***Wei et al., 2020***):

- Raising the bed's head to a position around 30 and 45 degrees.
- Everyday sedation decrease or interruption and extubation preparation evaluation.
- Preventing peptic ulcer diseases.
- Preventing thromboembolic diseases (***Vlisides et al., 2020***).

Thoracic radiography and computed tomography are typically used in addition to clinically and laboratory data to advise breathing assistance. The evaluation of pleural effusions, pneumothoraces, and lungs pathologies (consolidation, pulmonary edema, etc.) can now be done at the patient's bedside utilizing lung ultrasonography without utilizing radiotherapy or removing the patients from the security of the intensive care unit (***Danziger et al., 2020)***.

2.3.5. Cardiovascular support

The goal of hemodynamic treatment for critically ill patients is to maximize oxygen supply to the various organs systems and organs perfusions. This strategy's pillars include prudent hydration control and the usage of vasodilation medications depending on routine monitoring of cardiovascular abnormalities (***Sanz et al., 2020***).

Haemodynamic monitoring: The evaluation of hemodynamic abnormalities in severe illness is famously challenging due to their complexity. Physicians need to combine complicated data from external resources and take into account pathophysiological disturbances to both microcirculation and microcirculation. This list consists of the past medical history, physically evaluation, clinical findings, and numerous monitoring techniques (***Ball et al., 2020***). The latter frequently measure either pressure (using instruments like arterial or central venous pressures monitoring) or blood circulation (such as cardiac output monitors). Owing to its high dangers and lack of better patient outcomes, invasive cardiac output measuring techniques like pulmonary artery flotation devices have fallen out of favour (outside of dedicated cardiac ICUs). Furthermore, a number of less intrusive procedures have been discovered, including esophageal Doppler instruments and artery pulses contour analyses (i.e. LiDCO) (***Browne & Braden, 2020***).

Since most evaluations are generated instead of evaluated, they work best when applied dynamically, like when evaluating a person's reaction to a changing situation. Several critical care specialists are now tasked to conduct focused echocardiogram examinations, and specialized studies like echocardiography are playing an expanding importance in the hemodynamic assessments at the bedside (***Hashmi et al., 2020)***.

Fluid management: Restoring a sufficient circulation capacity to ensure organ perfusions is the aim of fluid resuscitation. Consequently, considerable organ edema might result from endothelial injury and capillary leaking ***(Jouparinejad, Foroughameri, Khajouei, & Farokhzadian, 2020)***, This in consequence may negatively impact the transport of nutrients and oxygen. When a patient is admitted to the Intensive care unit, having a cumulatively positive fluids balancing has been linked to worse treatment practice. The necessity of maintaining fluid balance cannot be emphasized because fluids control is a complex balance of possibly opposing needs ***(Fink, Jarvis, et al., 2020).***

The best kind of intravenous fluid—a crystalloid or a colloid—to employ for recovery and management throughout severe illness is still up for debate. If a colloid is selected, albumin is a recognized safe option in septic and liver illness. Balancing crystalloid treatments are most frequently used in sepsis, bloody products in severely trauma

(***Huang et al., 2020***). Gelatins lacking proof of benefits or damage, and starch treatments should be ignored resulting in potential nephrotoxic adverse effects and likely higher mortality ***(Onwochei et al., 2020).***

All sufferers, such as the general acute medical community, may wait to get a blood transfusion till their haemoglobin is less than 70 g/L. At that point, single unit aliquots of blood must be provided (***Newsome et al., 2020***).Therefore, a larger criterion might be taken into account if bleeding is present or anticipated, if a patient has had a previously myocardial infarction, or if they have unstable angina (**Fukuda, Sakurai, & Kashiwagi, 2020)**.

Vasodilation medications and their concepts of use: In a range of critical disease circumstances, short- to medium-acting medications called vasopressors and inotropic medicines are being used to improve cardiac outputs or vascular tones ***(Johnston, Barrett-Jolley, Krige, & Welters, 2020)***. They are employed as a temporary fix until the disease processes is resolved and adequate cardiovascular functioning is restored (***Kydonaki, Kean, & Tocher, 2020***).

Vasopressors cause peripheral blood arteries' smooth muscular contractions, increasing both the vascular resistance and the constricting of venous capacitor vessels. Most frequently, an increase in blood pressure is the reported overall impact. Norepinephrine, epinephrine, metaraminol, phenylephrine, dopamine (through a-adrenoceptor action), and vasopressin are examples of commonly utilized vasodilators (via vasopressin V1 receptors) (***Murugan et al., 2020***).

The myocardium's increased contraction as a result of inotrope use raises cardiac function. Epinephrine, dobutamine, milrinone, and dopaminergic (through b-adrenoceptor activity) are a few forms of inotropes that are frequently utilized (a phosphor diasterase inhibitor). A more recent inotrope called levosimendan acts by raising myocardium responsiveness to calcium ***(Despres et al., 2020).***

Individuals who are septic frequently need increasing hemodynamic assistance. Following vigorous intravenous fluids, escalating vasopressor dosages are administered (e.g. norepinephrine followed by the addition of vasopressin). To lower the dosage and durations of vasopressor therapy, hydrocortisone might well be administered. Temporary inotropic stimulation (with dobutamine or epinephrine, for example) could be necessary if sepsis-induced cardiac failure is anticipated (***Pazienza et al., 2020)***.

2.3.6. Central nervous system

A modified sensorium, more frequently a decreased degree of awareness and frequently documented using the Glasgow Coma Scale, can cause admissions to the intensive care unit (ICU) (GCS). As the patients would be at danger of receiving their airways compromised, they need to receive ICU treatment (***Delgado et al., 2020***).

Individuals with spinal or intracranial pathologies require neuroprotective care (e.g. traumatic brain injury, ischemic strokes, intracranial bleeds, spinal cord ischemia). It necessitates a complex multifactorial strategy, with careful ventilator and hemodynamic care being of greatest priority (***Kharatzadeh et al., 2020***). Modern scanning and measuring technologies, such as those that measure intracranial pressure or neurological function, can now be used to guide therapy choices. Extra cranial illness mechanisms also run the potential of resulting in secondary brain damage that might be prevented.

Focused temperature control and the avoidance of hyperthermia are two examples that could help individuals who survive heart attack outside of a hospital have better neurologic outcomes (***Craig, Kalanxhi, & Hauck, 2020)***.

2.3.7. Renal support

Since the fatality rate for critically ill cases of acute renal damage is still significant, it poses a huge clinical problem for the critical care staff. AKI affects up to 67 percent of the overall Intensive care unit community (40e50 percent). According to the KDIGO classification of AKI, intensity is categorized into stages between 1 and 3 depending on serum creatinine and urinary outputs (***Squizzato et al., 2020)***.

In severe illness, pre-renal factors (hypertension, sepsis, decreased heart function) frequently act as the primary precipitating agent of AKI. Furthermore, through the ICU hospitalization, renal failure frequently develops complex, for instance due to parenchymal damages from nephrotoxic medications. Though uncommon in the severely unwell, post-renal diseases must be ruled out (***Feddeh & Darawad, 2020)***.

2.3.8. Gastrointestinal support and nutrition

When patients are admitted to the Intensive care unit, majority of them are underweight. Their capacity to tolerate the physiologic demands of severe disease is significantly impacted by this. Additionally, serious illness could have a direct impact on gut health and disrupt nutrient health (***Kang et al., 2020***). Malnourishment can raise the infection risk, promote slow tissue repair, and cause muscle mass losses. Hence, it is critical to enhance treatment outcomes to conduct full nutritional assessments upon arrival to enabling conditions individuals and to provide adequate nutrition promptly. When deciding whether to start feeding postoperative patients, the physician plays a crucial role. It is not always easy to decide whether to begin early enteral feeding, delayed eating, or begin parenteral nutrition (***Aslan et al., 2020***).

There has been much debate on the best method of nutritional needs. Prokinetics are widely used to aid parenteral nutrition, which frequently requires nasogastric or nasojejunal feeding tubes (metoclopramide and erythromycin). Enteral feeding is typically given through central veins and offers a different approach in cases of chronic gut dysfunction (***Tzotzos et al., 2020)***. Both treatments have a lot of challenges attached to them. Earlier enteral feeding is currently preferred over earlier parenteral nutrition because it has more dangers and less obvious advantages for patients (***Morrill et al., 2020***).It is still debatable how dietary supplementations and immunonutrients like glutamine and arginine should be used. Today, glycemic management is a crucial component of effective intensive caring. Furthermore, due to the considerable risk of hypoglycemia with the previously recommended intense insulin treatment, blood glucose objectives have been reduced (aim 10 mmol/L) (***Grier et al., 2020)***.

2.3.9. Neuromuscular considerations

Individuals who are critically ill frequently experience severe muscle weakness. Along with specific diseases like Guillain-Barre syndrome and myasthenia gravis which might necessitate intensive care hospitalization, many people also develop neuropathic pain, myopathies, or a mixture of the both (***Salehi et al., 2020***). These conditions are frequently referred to as ICU-acquired weakening (ICUAW). Muscular atrophy due to lack of use, sepsis, multi - organ failure disorder, access to certain medicines (such as corticosteroids and neuromuscular blocking medications), and starvation are some of the factors that contribute **(Zhang, Meng, & Chen**, ***2020)***. This is a typical problem in patients who have endured serious postoperative complications, including an anastomotic leak; these patients frequently needed numerous admissions to the operating room and necessitated substantial organ assistance. ICU AW could cause major difficulties in obtaining off of mechanical ventilation and getting out of the intensive care unit (***Tawalbeh, 2020***). Additionally, sufferers are vulnerable to muscular contractures. Earlier mobilization and frequent, vigorous physiotherapy are essential for reducing the effects of acute disease weakening (***Self et al., 2020***).

2.3.10. Sleep and delirium

Significant disruption of the patient's natural sleep-wake cycle is frequently linked to severe disease. On the intensive care unit, it might be challenging to maintain the appropriate state of daytime alertness and nighttime sleep. The underlying medical processes, adverse drug reactions, repeated treatments, discomfort, artificial organ supporting, and loud noises and bright lights are all contributing factors ***(El Tahan et al., 2020***). Consequently, attempts to lessen the bad impacts of sleep disruption concentrate on reducing the aforementioned health risks and encouraging good sleep hygiene by restoring a normal circadian rhythm. Additionally, some departments use melatonin, analgesia-based sedation protocols, and pharmaceutical measures including sedation breaks (***Haina Jr, 2020)***. The patients and related experiences as well as the recovery to functioning after discharging can be improved by being aware of the psychological components of severe illness and disability (***Maddock et al., 2020***).

2.4. Further critical care considerations

Critical care involves several different disciplines. The expertise of other specializations, especially physiotherapy, pharmacology, nourishment, microbiological, radiography, psychiatry, and speech and language specialists, is crucial in addition to that of the physician critical care professionals (***Ottolenghi et al., 2020)***.

2.4.1. Infection control

Individuals who are in critical condition are more likely to get infections caused by multi-resistant germs. These "super bugs" are frequently prevalent only in a certain nation, hospitals, or intensive care department. Antibiotic management plays a significant role in the daily care of critically ill patients (***Hardenberg, Rana, & Tori, 2020***). In surgery patients, it's crucial to make sure that the proper prophylactic is administered intra - operative and that postoperatively medications are only dispensed in compliance with the best possible evidence-based antibiotic stewardship practices (***Varshney et al., 2020***).

2.4.2. End-of-life care

Unavoidably, some individuals will pass away on the ICU as a result of their fundamental sickness. According to recent UK data, critical care unit fatality in regular ICUs is estimated to be approximately 13%, however actual rates will vary relying on the case mixes ***(Martillo et al., 2021)***.The planned advantages of continuing treatments must be weighed against the possible hardship for the patients because prognostication is not accurate. Judgments on restricting or stopping life-sustaining treatments are necessary if it becomes clear that doing so would not be in the patient's best interests. Patients frequently find it difficult to communicate their desires precisely (***Trotta et al., 2020***).

Consequently, the emergency medicine and parents specializedteams are responsible for making this choice. In this procedure, meaningful conversations with the patient and family are crucial, if at all permitted. If discontinuing continuing medical intervention is considered acceptable, palliative care, which addresses symptom reduction, relaxation, and respect at the end of life, is becoming the primary priority (***Williams et al., 2020***).

2.4.3. Organs donations

All critically ill patients who are dying must be given the option of organ transplantation due to global shortages of volunteers. The UK recognizes two distinct pathways: donating after circulatory death (DCD) and donating following brain death (DBD) (***Auld et al., 2020***). For the latter, a rigorous method of brain-stem death examination is necessary for the identification. (***Catling & Wolff, 2020***).After DBD, immediate physiologic stabilization and donation optimizing enhance the success of transplants. Organ recovery by the recipient groups could be arranged by specialized organs donations teams, who can also assist the donor's relatives and smooth the donating procedure (***Rus et al., 2020***).

2.5. Overview of Mechanical Ventilation

Mechanical ventilation could be

- Non-invasive, utilizing several kinds of protective masks
- Invasive, requiring intubation of the trachea (***Hemilä & Chalker, 2020***)

2.5.1. Considering respiratory mechanics is necessary for the identification and implementation of existing methods

Endotracheal intubation and mechanical ventilation have several justifications, however, generally speaking, mechanical ventilation must be taken into account when there are clinical or laboratory symptoms that the patients cannot retain the airways or get enough oxygenation or ventilation (***Solaimanzadeh, 2020***).

Concerning findings include

- Respiratory rate > 30/minute
- Inability to maintain arterial oxygen saturation > 90% with fractional inspired oxygen (FIO2) > 0.60
- pH < 7.25
- Partial pressure of carbon dioxide (PaCO2) > 50 mm Hg (unless chronic and stable) ***(Wang et al., 2020).***

Simple numerical parameters cannot be used to determine whether to start mechanical breathing; instead, clinically judgment that takes into account the overall clinical condition should be used. But you shouldn't wait to start ventilators until the patients are in critical condition (***Sklar et al., 2020***).

Respiratory Mechanics

A pressure difference between the atmosphere and the alveolar is produced by normally inhalation, which results in negative intrapleural pressures and air inflow.

The pressure difference in mechanical ventilation is caused by the gas source's higher (positively) pressures (***Dres et al., 2020)***.

Peak airway pressure is evaluated at the airways openings (Pao), and mechanical ventilators typically display it. It is made up of pressures arising from the elastic tissue of the lungs (pulmonary (elastomeric pressures), the alveolar pressures present at the start of the exhalation, and the opposition to the ventilator flows (resistor tension). It provides the general pressure required to push an amount of gas into the lungs (positively end-expiratory pressures [PEEP]) (***Mahase, 2020***). Thus,

$$\text{Peak airway pressure} = \text{resistive pressure} + \text{elastic pressure} + \text{PEEP}$$

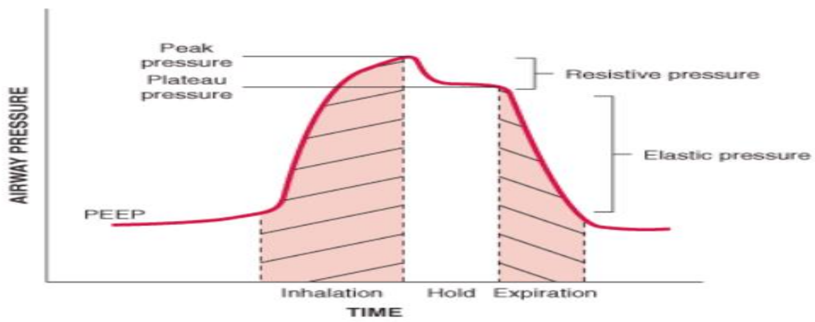

Figure (1): Using an inspiratory-hold maneuver, an illustration of an airways pressures element throughout mechanical ventilation. PEEP stands for positive end-breathing pressures (***Pham, Brochard, & Slutsky, 2017***).

Resistive pressure is the result of airflows and circuits impedance. Resistance to airflow develops in the participant's lungs, the ventilator circuits, and the endotracheal tubes in critically ill adults (***Gamberini et al., 2020***).

Elastic pressure is the result of the amount of gas given and the elasticity rebound of the airways and chest walls. Higher lungs stiffening (as in pulmonary fibrosis) or constrained excursions of the rib cage or abdomen, for a given amount, increases elasticity pressures (as in tense ascites or massive obesity). Elevated elastics is equivalent to poor compliances since elastics is the opposite of compliance (***Urner et al., 2020***).

End-expiratory pressure: the pressure in the lungs typically matches that of the atmosphere. Conversely, end-expiratory pressures could be positive in relation to the surroundings when the alveoli are unable to fully clear due to a blockage in the airways, a restriction in the airflows, or a reduced expiratory duration. To distinguish it from applied external (physiologic) PEEP, which is produced by changing the mechanical ventilator or by donning a tight-fitting masks that exerts positive pressures all through the breathing process, this force is referred to as intrinsic PEEP or auto PEEP (***Gattinoni et al., 2017***).

Any increase in peak airway resistance (for example, greater than 25 cm H2O) must trigger assessment of the end-inspiratory pressures (plateau pressure) by an end-inspiratory holding manoeuvre in order to assess the respective contributions of elasticity and resistance pressures. Exhaling slowly is delayed by the manoeuvre, which maintains the exhalation valves shut for an extended 0.3 to 0.5 seconds following intake. As airflow stops throughout this period, lung pressure decreases from its maximal value (***Hess & Kacmarek, 2019***). Whenever PEEP is removed, the end-inspiratory pressures that result indicates the elasticity pressure (Considering the patient isn't actively contracting their muscles to inhale or exhale when the measurements are being taken). The resistance pressure is the difference between maximum and plateau pressures (***Gattinoni, Quintel, & Marini, 2020)***.

Elevated resistive pressure (for instance, > 10 cm H2O) could mean that there is a bronchospasm or intraluminal masses, or that the endotracheal tubes have been tangled or blocked with secretions (***Wunsch, 2020***).

Increased elastic pressure (for instance, > 10 cm H2O) indicates lower lung flexibility because

- Lobar atelectasis, fibrosis, or edoema
- pneumothorax, pneumomediastinum, or fibrothorax
- Extra - pulmonary limitation that could be brought on by excessive overweight, ascites, pregnancies, circumferential burning, or another chest wall defect (***Tobin, Laghi, & Jubran, 2020)***.
- A tidal flow that is excessive compared to the volume of lungs being ventilated (such as when a single lung receives a typical tidal volume since the endotracheal tubing is improperly located) (***Walter, Corbridge, & Singer, 2018)***.

Intrinsic PEEP (auto PEEP) through an end-expiratory holding manoeuvre in the inactive patients. The expiratory port is shut for two seconds just before inhaling. When flow stops, resistance pressure is eliminated, and the pressure that results represents the pulmonary pressures at the conclusion of expiration (intrinsic PEEP) ***(Poor, 2018)***. However patients must be completely passive on the ventilator for an appropriate measure to occur, neuromuscular blockage should not be used exclusively to assess intrinsic PEEP. Examining the exhalation stream tracking is a non-quantitative way to find intrinsic PEEP (***Kneyber et al., 2017***). Intrinsic PEEP is observed if exhalation pressure remains till the subsequent breathing or if the patient's lungs do not settle before the subsequent inhalation. Greater inspiratory labour of breath and reduced venous return are side effects of high intrinsic PEEP that may lead to hypotension and reduced blood flow ***(Mackle et al., 2019).***

The discovery of intrinsic PEEP may spur an investigation into the factors obstructing airflow (such as bronchospasm, reduced elastic recoil, and airways discharges); Nevertheless, in patients without airflow restriction, increased respiratory rate (> 20 L/minute) solely can cause intrinsic PEEP ***(Subirà, de Haro, Magrans, Fernández, & Blanch, 2018).*** Reducing the inspiratory period can lower intrinsic PEEP if breathing restriction is the root reason (increasing the inspiratory rate, etc.) or slowing down the breathing process to enable more of the breathing process to be consumed exhaling **(Arnal et al., 2018).**

2.5.2. Means and Modes of Mechanical Ventilation

Mechanical ventilators are

- Volume cycled: Supplying a fixed volume with every exhale (pressures might indeed differ),
- Pressure cycled: Consistent pressures delivery with each inhalation (Volumes provided could change),
- Volumes and pressure were cycled together (***Ball et al., 2017)***.

No matter if the patient takes a spontaneously breathing or not, assist-control (A/C) techniques of breathing sustain a minimal breathing rate. Whether the ventilation is pressure cycling or volume cycling, each particular amount would correlate to a certain pressures and conversely since pressures and volumes are specifically connected by the pressure-volume curves (***Simonds, 2016***).

Variable ventilator parameters comprise, but are not limited to:

- Respiratory rating,
- Tidal volumes,
- Trigger sensitivity,
- Flow rating,
- Waveforms,
- Inspiratory/expiratory (I/E) ratios **(Morton et al., 2019).**

2.5.3. Volume-cycled ventilation

A fixed volume of fluid is delivered using volume-cycled ventilating. This data associated with

- Volume-controlling (V/C)
- Synchronized intermittent mandatory ventilations (SIMV) ***(Vaporidi et al., 2017).***

The determined flow velocity and the impedance and collaborating of the respiratory affect the final lung pressures, which are not constant ***(Rose et al., 2017).***

V/C The easiest and most efficient way to provide complete ventilatory support is through ventilation. In this method, the supply of the specified tidal volume is triggered by each inspiratory attempt that exceeds the predetermined sensitivities threshold. The respirator starts a breathing if the patients don't activate it regularly enough, providing the appropriate minimum breathing rate (***Brochard, Slutsky, & Pesenti, 2017)***.

SIMV provides breathing at a predetermined rate and volume that are timed to the patient's attempts. Unlike V/C, patient attempts over the predetermined respiratory rate are unaided, even while the intake valve releases to permit breathing. Although research proving that it does not fully support the ventilator like V/C, does not make it easier for patients to be released off mechanical ventilation, and does not enhance patient satisfaction, this method is nevertheless widely used (***Greenough et al., 2016)***.

2.5.4. Pressure-cycled ventilations

An established inspiratory pressure is provided via pressure-cycled ventilation. This mode consists of

- Pressure controlling ventilations (PCV),
- Pressure supporting ventilations (PSV) and
- non-invasive treatments delivered through a snug-fitting face mask (several varieties are offered) (***Mahmood & Pinsky, 2018***).

As a result, the pulmonary system's resistance and collaborating affect tidal volume. This phase might lead to unnoticed alterations in respiratory rate related to variation in the respiratory system functioning (***Kaier et al., 2020***). Conceivably, this method could help cases with acute respiratory distress syndrome (ARDS) because it reduces the rupturing stresses of the respiratory system; nevertheless, no obvious clinically benefits over V/C has been demonstrated, and the rupturing demands will be the same if the volume provided by PCV is the same as that provided by V/C (***Snoek et al., 2016***).

Pressure control ventilation is a pneumatically variation of air conditioning. Every effort to inhale that exceeds the predetermined sensitivities level results in full pressure supports that is sustained for a preset amount of time. Maintaining a minimal respiration rate ***(Schepens et al., 2019).***

In **pressure support ventilation,** there is no minimum rating established; the participant initiates each breathing. When the patient's inspiratory circulation drops below a certain threshold specified by algorithms, the ventilator helps the patient by maintaining a steady pressure till that threshold is reached (***Kózka et al., 2020***). Therefore, a patient's lengthier or greater inhalation produces a higher tidal volume. By allowing patients to do more of the work of breathing, this mode is frequently utilized to free sufferers from artificial ventilation. Unfortunately, no research have shown that this strategy is superior to others in ending mechanical ventilation (***Ambrosino & Vitacca, 2018***).

2.5.6. Noninvasive positive pressure ventilation (NIPPV)

NIPPV is the provision of positively pressure breathing through the use of an uncomfortable mask that conceals the mouth and/or nose. Individuals who could not tolerate the traditional tight-fitting surgical masks have an option in the form of headgear that provides NIPPV. Despite volumes management can be employed, pressure assist ventilations or delivering end-expiratory pressure are the main uses of NIPPV due to its application in individuals who are freely inhaling (***Pelosi et al., 2021***).

NIPPV could be administered as

- Continuous positively airway pressure (CPAP)
- Bi-level positively airway pressure (BiPAP) ***(Branson, 2018).***

In **CPAP,** Without further inspiratory assistance, consistent level is controlled during the whole breathing cycle (**Grübler et al., 2017)**.

With **BiPAP,** The patient triggers respiratory rate while the doctor controls the patient's expiratory positively airway pressures (EPAP) and inspiratory positively airway pressure (IPAP) (***Grübler et al., 2017***).

Patients should have enough mental capacity, airways protection responses, and no indications of impending operation or need for transportation off the floor for lengthy operations in order to avoid vomit in any manner. Patients who are obtunded and have a lot of secretions are not potentially suitable (***Keller et al., 2020)***. NIPPV ought not to be used in individuals with hemodynamic instability or those who have signs of reduced gastric emptying, such as those who have an ileus, a bowel blockage, or are pregnant. Massive air swallows under these conditions could cause inhalation and life-threatening vomit. In order to prevent gastric insufflation, IPAP should be adjusted under esophagus opening pressure (20 cm H_2O) (***Zhou et al., 2017)***.

The onset of shock or regular arrhythmias, myocardial infarction (mi, and transportation to a cardiac catheterization experiment or surgeries suite in which regulation of the airways and fully respiration assistance are preferred and indications for converting to endotracheal tube feeding and traditional mechanical ventilation (G***rasselli et al., 2021***).

The use of NIPPV is possible in outpatient's environment. For instance, although BiPAP could be utilized for individuals with concurrent obesity-hypoventilation syndromes or for continuous breathing among those with neuromuscular or thoracic illnesses, CPAP is frequently utilized people with obstructive sleep apnea (***Goligher et al., 2018***).

2.5.7. Ventilator settings

Although the ventilation parameters are customized for the fundamental situation, the following fundamentals apply

Tidal volume and **respiratory rate** set the minute ventilation. A capacity that is either too large or too low can cause artificial inflation or atelectasis. A frequency that is very high runs the danger of respiratory alkalosis, breathlessness, insufficient exhalation duration, and auto PEEP; a rate that is too little runs the risk of respiratory acidosis and insufficient minute ventilations (***Hemilä & Chalker, 2020***). The first recommendation for individuals with respiratory failure was a low tidal quantity of 6 to 8 mL/kg ideally body weight (IBW); nevertheless, thus a low tidal amount is typically also adequate in certain individuals who have normal tissue dynamics (***Chang et al., 2021***), like as patients undergoing an operation while using mechanical ventilation ***(W. Li et al., 2020)***. Other individuals (such as those who have undergone trauma, are obtunded, or have severely acidosis) might begin with a relatively greater vital capacity (for example, 8 to 10 mL/kg). For patients with lung diseases requiring mechanical ventilation, IBW is utilized to calculate the required tidal volume instead of original body mass ***(de Haro et al., 2018):***

IBW (kg) Males:

$$50 + 2.3(\text{height in inches} - 60)$$

$$\text{or} \quad 50 + 0.91(\text{height in cm} - 152.4)$$

IBW (kg) Females:

$$45.5 + 2.3(\text{height in inches} - 60)$$

$$\text{or} \quad 45.5 + 0.91(\text{height in cm} - 152.4)$$

Sensitivity varies the minimum amount of negatively pressures needed to start the ventilators. A standard configuration is -2 cm H_2O. Settings that is too higher (for example, more negatively than -2 cm H_2O) prevents weaker individuals from inducing a breathing ***(Biddison et al., 2019)***. By forcing the device to automatically cycle, a level that is very lower (less negatively than -2 cm H_2O, for example) could cause over-ventilation. Excessive auto PEEP individuals (such as those with COPD or asthma) could find it challenging to breathe deeply enough to obtain a suitably negatively intra-airway pressures (***Bellù et al., 2021***).

The **I:E ratio** (inspiratory: expiratory ratios) measures how much time has been spent inhaling compared to exhaling. Certain ventilation techniques allow you to change the I:E ratios. For individuals with typical mechanics, a standard setting is 1:3. To decrease the amount of auto PEEP in asthma patients or COPD (chronic obstructive lung diseases) exacerbations, rates of 1:4 or even higher should be used (***Mahase, 2020)***.

The **inspiratory flow rate** could be altered in certain ventilating techniques (I.e., only one of the two variables—the flow ratio or the I: E rate—can be changed). In order to allow for more time in exhalation and reduce auto PEEP, the inspiratory rate must typically be set at around 60 L/minute, but it could be expanded significantly to 120 L/minute for individuals with breathing limitations (***Lucarelli et al., 2020)***.

FIO2 (fraction of oxygen supply) is first adjusted to 1.0 (100 percent oxygen) and then is reduced to the lower amount required to keep sufficient respiration ***(Radunovic et al., 2017).***

PEEP whatever ventilation setting could be used. PEEP lessens airspace closure at the ending of expiration and raises end-expired lungs capacity. PEEP at 5 cm H2O could be beneficial for the group of cases on artificial breathing to reduce the respiratory distress that commonly follows tracheal intubation, sedation, paralysis, and/or recumbent lying ***(Lai et al., 2018).*** Increased PEEP improves oxygen in conditions like ARDS and cardiogenic pulmonary edoema. PEEP enables the use of reduced FIO2 levels while maintaining sufficient arterial oxygenation. This action might play a significant role in preventing lung damage from extended exposures to higher FIO2 ($\geq$ 0.6) levels (***van Kaam et al., 2021***). PEEP can decrease left ventricular afterload, enhance intrathoracic pressure, and, if excessively higher, may obstruct vascular resistance and cause hypertension in an individual who is hypovolemic. These effects could result in ventilator-associated pulmonary infection (***Yoshida et al., 2017***). In comparison, lower PEEP can lead to cyclical airspace opening and closing that can lead to recurrent shear stresses that can lead to VALI. It's critical to remember that the pressure-volume curves differs for various lungs areas. Due to this variance, depending versus nondependent lungs areas would have a lesser rise in capacity for a particular PEEP (***Navarro-Millán et al., 2020)***.

2.5.8. Patient positioning

The individual is often placed in a supine, semi-upright posture for mechanical ventilation. Furthermore, supine lying can improve oxygen in ARDS patients, mostly by promoting higher balanced breathing (***Gamberini et al., 2020***). The quantity of shunted is often largest in the lateral and posterior pulmonary areas. Consistent breathing minimizes this quantity while exhibiting negligible effects on circulatory allocation (***Bertoni, Spadaro, & Goligher, 2020***).

Though several researchers recommend testing prone positions in ARDS individuals who need high doses of PEEP (e.g., > 12 cm H_2O) as well as FIO2 (such as, > 0.6), preliminary studies did not demonstrate a reduction in the incidence with this approach (***Hill et al., 2017***). Individuals with moderate severity ARDS (PaO_2:FIO^2<150 mm Hg on a FIO_2 0.6, PEEP > 5 cm H_2O) and who were on a vital capacity of around 6 mL/kg were evaluated in a global context, multidisciplinary, randomized experiment. These individuals were given the option of being positioned prone for aperiod of ≥16 hours throughout ventilation or being left in the supine posture ***(Hua et al., 2020)***. The research, that involved a total of 466 participants, found that the prone-positioning cohort had lower 28- and 90-day mortality without a significantly higher frequency of related comorbidities. The superior outcomes compared to past trials are assumed to be the consequence of positive impact on patient choice and management techniques (***Dellaca & Veneroni, 2017***).

In one significant clinically research, prone position improved hypoxemia in conscious, autonomously inhaling COVID-19 patients on elevated nasal cannulas oxygenation and reduced the probability of therapeutic failure, characterized as the requirement for induction or mortality within 28 days (***Ceriana et al., 2019***).

Individuals with spine instabilities or elevated intracranial pressures should not be positioned prone. The personnel of the ICU must also concentrate on this positioning to prevent issues like the displacement of the endotracheal or intravascular catheterization (***Angelidi et al., 2021***).

2.5.9. Sedation and comfort

While many individuals can manage artificial breathing with an endotracheal without sedation, some need to be given sedatives intravenously (procedural sedation, ativan, chloroform) and analgesia (morphine, morphine, etc.) to reduce pressure and anxiety. These medications can also somewhat lower energy expenditures, which lowers carbon dioxide generation and breathing use. To achieve the intended outcome, dosages must be adjusted in accordance with established sedation/analgesia grading systems (such is the Riker Sedation-Agitation Scaling and the Richmond Agitation-Sedation Scaling) (**Rackley, 2020**). Individuals with ARDS who are on artificial breathing often need more sedation and analgesics. Serum triglycerides concentrations must be periodically monitored (for instance, every 48 hours) if propofol is used for periods longer than 24 to 48 hours. There is proof that ventilation system lasts longer when IV sedative is constantly delivered. Therefore, the objective is to achieve sufficient but not severe sedation, that can be achieved by either periodic infusion or continual sedation with everyday interruptions (***Ioannou et al., 2020***).

Neuromuscular blocking agents due to the potential for protracted neuromuscular failure and the requirement for ongoing conscious sedation, are not commonly used in patients receiving mechanical ventilation; nevertheless, one research discovered a reduction in mortality at 90 days in people with acute, serious ARDS who obtained 48 hours of spinal anesthesia (***Sha & Qi, 2020)***. However, when initial neurological blockage in ARDS was compared to lesser sedation without neuromuscular blockade in a bigger follow-up research, these results were not repeated (***Prasa et al., 2017***). Consequently, it is not advised to routinely paralyse people with acute ARDS. Individuals who struggle to endure some of the more complex and advanced forms of mechanical ventilation and those who need to avoid shaking when freezing is employed after cardiac arrest are two considerations who could profit from spinal anesthesia ***(Wilson et al., 2018***).

2.5.10. Complications of mechanical ventilation and safeguards

Mechanically ventilation problems can be split into those brought on by

- Endotracheal intubations,
- Mechanical ventilation itself and
- Prolonged incapacity to move around and irregular eating (***de Vries et al., 2018)***

The risks of sinus, ventilator-associated infections, trachea stenosis, vocal cord trauma, and, very infrequently, tracheal-esophageal or tracheal-vascular junction increases when there is an endotracheal tubing present. A febrile individual with an exudate trachea perforate and an increased white blood cell count > 48 hours into breathing implies ventilator-associated infections ***(Zhao & Liu, 2020).***

Pulmonary edema as well as pneumatoceles, oxygen toxic effects, hypotension, and ventilator-associated respiratory problems are all side effects of continued mechanical ventilation ***(Diaz & Heller, 2019).***

Oxygen toxicity is a term used to describe the inflammation alterations, pulmonary infiltrate, and subsequent evolution of pulmonary fibrosis which could occur after extended exposed to elevated FIO2 (e.g., > 0.6). Dosage and duration both affect toxicity. Avoiding a FIO2 < 0.6 unless absolutely essential for survival. For a long time, a FIO2 of less than 0.6 is allowed ***(Dar et al., 2021).***

Ventilator-associated lung injury (VALI), Alveolar and/or small airways injuries is frequently referred to as ventilator-induced pulmonary infection and is caused by mechanical ventilation. Alveolar dataexplore the dataexplore (also known as volutrauma) and the friction force produced by the repeated closure of alveoli (also known as atelectotrauma) are two potential methods. These factors can consider releasing pro-inflammatory cytokines, which enhance pleural space permeation, oedema, and silane absence ***(Jubran et al., 2019).***

The tensions fracture must always be evaluated if severe hypotensions manifest in a ventilated patients, particularly if it is followed by tachycardia and/or a fast rise in maximum inspiratory pressures. Individuals with these signs must get a lung check and a chest x-ray almost away (or urgent therapy if a confirmed test scored) (***Chakkarapani et al., 2020***).

Furthermore, sympathetic lysed brought on by sedation or opiates used to aid in insertion and breathing is more frequently the causes of hypotensions. In patients undergoing elevated amounts of PEEP and those with elevated amounts of intrinsic

PEEP since of asthma symptoms, reduced vascular resistance owing to increasing right ventricular could also result in hypotension (***Robba et al., 2019***). The patient might well be removed from the ventilator and softly nabbed individually at 2 to 3 breathe deeply with 100 percent oxygen while liquids are being imbued when there are no physically findings implying suspense pneumothorax and if ventilation-related reasons of hypotension are a potential etiology, awaiting a handheld chest x-ray (for instance, 20 mL/kg for youngsters and 500 to 1000 mL of 0.9 percent saline for adults) ***(Luongo et al., 2016)***. If symptoms resolve right away, there may be a ventilation-related issue, and the ventilator rates must be modified completely ***(Janssens et al., 2020)***.

Relatively immobility raises the danger of airway obstruction, deep vein thrombosis, and other venous thromboembolic diseases (for example, pulmonary embolisms) (***Grippa et al., 2017***).

Successfully controlled are used in most institutions to lessen difficulties. The danger of breathing machine infections is reduced by raising the heads of the bed by more than 30 degrees, and the danger of skin deterioration is reduced by routinely rotating the patients every two hours (***Teboul et al., 2019***). All participants treated with mechanical ventilators should obtain deep vein thrombus formation prophylactic, which can be accomplished by administering low - molecular - weight heparin or heparin 5000 modules parenterally two to three times per day, or, if heparin has been ingested, mechanical chest compression gadgets or fondaparinux (***Rinott, Youngster, & Lewis, 2021***). Patients will require histamine-2 blockers (such as famotidine 20 mg enteral nutrition or IV twice per day) or is around to stop gastrointestinal problems (1 g enterally four times per day). Treatments must only be provided to people who have an actively bleeding problem or previous indications. Regular dietary assessments are required, and if continued artificial breathing is expected, endotracheal tubes nutrition should be started (**Thibodeaux et al., 2020**).

Limiting the time of ventilators is the most efficient strategy to lower problems. The earlier time at which the patients might well be released from structural component is determined through daily "sedation vacation" and spontaneous breathing tests (***Yan et al., 2018)***.

2.6. Pain assessment tools according to mechanically ventilated patients

2.6.1. Pain evaluation in Intensive Care Units

The American Pain Society created the "Pain as the Fifth Critical Signs" project over the past 20 years. This suggestion is intended to raise experts' attention of the inclusion of assessing pain to the existing vital signs monitoring of blood pressures, pulses, temperatures, and breathing (***Chow et al., 2021***).All medical workers who actively manage for critically ill patients are advised to complete this pain evaluation form. To evaluate pain inside the Intensive care unit, nurses, physicians, physiotherapists, and other carers should do so routinely and repeatedly using systematic, reliable, and practical instruments (***Orso et al., 2021)***.

Investigations documenting the effect of this practice in ICUs demonstrate its significance for the results of critically ill patients. There is proof that the implementation of pain control procedures leads to improved pain control, more effective use of analgesics and/or sedatives, a reduction in the time spent on intermittent mechanical ventilation (IMV), a higher likelihood of tapering from IMV, a decreased risk of developing ventilator-associated bronchitis, central catheter-related diseases, urinary infections, and septicemia, a shortened stay in the intensive care unit (ICU), a reduction in agitation incidents (***McGuinness et al., 2020***). Depending on these encouraging results, pain evaluation is seen as a tactic for improved Intensive care unit treatment. The two techniques most frequently employed in this field are behavior assessment and vital sign recordings. The following will include descriptions of these and other pain measurement tools ***(Sauthier, Rose, & Jouvet, 2017).***

The most popular behavior measure for assessing pain in patients who are unable to self-reporting is the CPOT. Gélinas et al. verified it for the first time in Canadian patients undergoing heart surgery in 2006 (***Gélinas et al., 2006***). This technique can be used on people who are endotracheal intubation or not heavily sedated and contain four behaviors: face movements, motions, tense muscles, and respiratory adherence. CPOT has several psychological qualities that have already been studied, and it has been evaluated and confirmed in many groups and cultures ***(MacIntyre, Rackley, & Khusid, 2021)***.

Spanish version: kappa 0.79 and 1.00,61; English version: intraclass coefficient [ICC] 0.80-0.9350; French version: weighted Kappa 0.52-0.8829; Internal consistency in the Swedish translation is 0.84,57 (Cronbach's α coefficients ranged from 0.31-0.8157, and two distinct Intensive care unit groups' sensitivities ranged from 67 to 86 percent) specificity (Between 78 to 83 percent in two distinct ICU cohorts) feasibility (Intensive care unit nursing concurred that it was practical, fast to be using, easily to comprehend, and rapid to finish),The usefulness of this measure for Intensive care unit pain evaluation has been confirmed by various research, which also support its criteria and divergent validities (***Saskia Rijkenberg et al., 2017***).

Analgesic and sedative administration following the pain evaluation process was positively impacted, according to a previous research that used CPOT adoption as a pain measuring procedure in an ICU. In this research, nursing staff used the French version of the CPOT on patients in the intensive care unit who were both medical and trauma cases for a 12-month period (n=30).Statistics on pain assessment and pain treatment were gathered retroactively from hospital records at three separate points in time: before deployment, three months after execution, and 12 months after execution. There has been a rise in reporting of pain assessments and in actions suggestive of pain. On the other hand, with the installation of CPOT, less analgesic, propofol, and morphine boluses were given out (***Azevedo-Santos et al., 2017***).

CPOT has drawbacks in addition to its benefits. It is noted that traumatic brain injury individuals have distinct facial emotions when subjected to nociceptors treatments comparing with other patients; hence, more research is necessary to verify its application in this ICU group ***(Jendoubi, et al., 2017).*** Additionally, it is noted as being challenging to learn how to operate this tool and to comprehend the ratings, both of which are complicated. CPOT is regarded as a well-designed behavioral technique for use with nonverbal severely sick people considering these drawbacks (***Francesco et al., 2018***).

In Intensive care unit, BPS is the 2nd most common pain measure. It measures conformity with breathing, upper extremity movements, and three behavioral dimensions (face movements). It is reliable across populations and nationalities ***(Kotfis***

et al., 2018). Internally consistent (Cronbach's score varied from 0.63 to 0.72) and inter-rater dependability (Kappa coefficient varied from 0.67 to 0.83 and ICC of 0.95) are examples of psychological qualities. Prior studies have validated the sensitivities, specificity, criteria, and divergent validity of the BPS (significant increasing of 2-3 points in BPS ratings after nociceptors processes), which supports the benefits of BPS use, include frequent pain evaluations and patients' favorable results ***(Heidarzadeh et al., 2017).***

The use of BPS in Intensive care unit improved healthcare quality and pain control. Users may perceive some elements differently, which constitutes a limitation in practice (***Kotfis et al., 2017)***. Confounding factors include the elements "moving of upper extremities," which might be confused with muscle contractions, and "compliant with respirator," which experts identify as the scale's least-clear element ***(Varndell, Fry, & Elliott, 2017***).

2.6.2. Description of the tools behaviors:

Facial expression in pain

The face contains a multitude of data about a person's emotional reactions. Facial expressions are the most commonly used pain behaviors in pain assessment scales for individuals who are unable to communicate verbally. Since Charles Darwin's "The Expression of Emotions in Man and Animals," which reported findings and in-depth justifications for why specific face features correspond with emotional states, face movement has been researched for decades ***(Temesgen et al., 2021).***

Preliterate individuals living in isolation made judgments of wrath, disgust, anxiety, sorrow, pleasure, and amazement, but these judgments were no different from those expressed by university students in eight literate societies throughout the world ***(Modanloo et al., 2019)***. Face expressions are indications of common emotions across countries, regardless of age, gender, or race/ethnicity, with diversity related to the emotion itself as well as what the emotion means to the individual exhibiting it and to others. The creation of the Facial Action Coding System (FACS) allows for the identification of specific facial muscles movements made in reaction to emotions. Stop-frame responses and slow-motion footage are often used to identify these facial muscular contractions (***Ivanovski et al., 2020)***.

According to the pain assessment tools (CPOT and BPS), since there is no discernible muscles tension in the patient's face, a value of 0 is assigned. A tight face, which is typically displayed as a scowl or lowered brow, receives a value of 1. A scoring of 2 denotes grimacing, which is the tightening of the cheeks muscles and contractions of the entire face, including the eyes. The patients might occasionally raise their mouth or, if they are intubated, they might bite the endotracheal tube. If the face expressions look different from a calm (0) or grimacing (2) face, it should be noted on the chart and assigned a scoring of 1 ***(Stoilovska et al., 2020).***

Body movements:

According to the nurse's clinical judgment, a patient receives a scoring of 0 if they are not moving at all or are still in regular positions. A value of 1 denotes defensive actions, in which the patients make slow, careful motions while attempting to touch or contact the painful area (***Paryad, Leyli, & Parsasalkisari, 2020)***. When the patients are agitated or restless, a rating of 2 is assigned. The patient in this instance makes repetitive motions, attempts to pull on tubes, attempts to sit up in bed, or is not cooperative. It should be noted that although bodily motions are less specific behaviors in respect to pain, they are nonetheless crucial in the overall assessment of the patient's suffering (***Damico et al., 2018)***.

Compliance with the ventilator

Once the patients are ventilated mechanically, adherence with the ventilation is used. A value of 0 indicates simple ventilation. Both the patient's coughing and the alarms are not being set off. A value of 1 indicates that, notwithstanding the patient's coughing or alarms activation, it ends on its own without the nurse's intervention. When the patient is resisting the ventilator, they receive a score of 2. In this situation, it's possible for the patient to cough while also setting off the alarms, causing an apparent asynchrony. The nurse must act by comforting the patients verbally or by giving the patients medicine to help them relax ***(Dorji, 2019)***.

Vocalization

When a patient is not intubated and is able to vocalize, it is used. A value of 0 denotes the lack of sounds or regular speech from the patients. Once patients are sighing or moaning, they receive a scoring of 1, and when they are screaming (Aïe! Ouch!) they receive a scoring of 2 or crying (***Bouajram et al., 2020)***.

Muscle tension

The second-best indication of pain in the CPOT is muscular tensions, which is also a very excellent sign of pain. By passively flexing and extending the patient's arms while they are at rest, the patient is assessed. Whenever the patient is rotating, the nurse assisting in the surgery can easily sense the patient's resistance. If there is no resistance experienced during the passive movements or the turning procedures, a scoring of 0 is awarded. A scoring of 1 denotes resistance to turning or moving. The patient is hence tense or stiff. A 2 represents very strong resistances. In these situations, the patient might oppose the nurse's rotating motion or the nurse might not be capable of completing passive motions. The patients can also tighten his or her fists ***(Bouajram et al., 2020***).

2.6.3. Psychometric Properties of CPOT and BPS

Birkedal HC, et al, 2021 ***(Birkedal, Larsen, Steindal, & Solberg, 2021)***, completed a thorough analysis of the two pain assessment measures that can be used with nonverbal critically ill adults who are on a ventilator to determine their psychometrical qualities. BPS and CPOT were the two pain evaluation measures that were examined. On October 1, 2019, they analyzed eleven papers that were pertinent to the five distinct pain measurement scales' validity, reliability, feasibility, and clinical value. In order to assess pain throughout operations in the intensive care unit, they set out to compare the therapeutic significance and measurements capabilities of the Critical-Care Pain Evaluation Tool with the Behavioral Pain Scaling. With ICU patients being unable self-reporting on pain, the Critically-Care Pain Observation Tool and the Behavioral Pain scaling both shown strong reliability and validity and were effective alternatives for managing pain throughout severe operations. The Behavioral Pain Scaling is a suitable substitute for the Critical-Care Pain Observation Tool, which has been found to have especially powerful reliability and validity in managing pain throughout operations. The systematic study suggested that COPT may also be a crucial tool for separating discomfort from pain in order to deliver the optimal care (***Ashkenazy & Ganz, 2019***). However, because the BPS only offers three levels for inspection as opposed to the CPOT's four, it is thought to be a little simpler to recall throughout clinical practice ***(Chanques et al., 2014).***

Validity

The CPOT and BPS pain assessment scale's validity describes how effectively it accurately assesses pain in critically ill ventilated adults (Hanafi, Muhammad, Wiyono, & Saptiwi, 2019). The CPOT and BPS pain scales have undergone substantial research to validate several elements of validity, including content validity, criterion - related validity, and discriminant validity ***(Fröhlich et al., 2020), (Nazari et al., 2022)***, ***(Kotfis et al., 2018), (Nazari et al., 2021).***

In the study done by Fröhlich, et al, 2020, With 249 measured values twice on forty adults, construct validity was calculated. No significant ZOPA elements were found in 182 measures (75.3 percent, $p < 0.001$) following the administration of analgesic. In addition, 47 individuals and 557 measures of all the elements were examined for incidence and combinations. This led to the creation of an ultimate device with 13 components. The authors saw various probability for a positively test result amongst three tools. In 28 of the 33 cycles, CPOT was positive (84.8 percent; 95 percent CI: 68.1 to 94.9 percent). Exactly 23 out of 33 cycles had positively testing results for the BPS

(67.0 percent; 95 percent CI: 51.3 to 84.4 percent). All three tests yielded positive results in 22 of the 33 cycles (66.7 percent ; 95 percent CI: 48.2 to 82.0 percent) ***(Fröhlich et al., 2020).***

The aforementioned work was replicated in a systematic review by (***Grosso et al., 2019***). To promote the humanization of healthcare, researchers looked at the commonly used pain measurement tools for severely sick, unconscious elderly patients. Using science investigation, the B-On and Ebscohost databases were searched from February 2012 to February 2018 for the systematic literature review. The Critical-Care Pain Observation Tool (CPOT) tool was reported to be the most effectively used and to have a favorable effect on pain management in adults with altered consciousness. The evaluation of pain is crucial for all individuals, but it is especially crucial for severely sick patients who are unconscious since it works to enhance and humanize the healthcare being given and determines whether the recommended medication is effective. The most effective scales for these individuals' pain assessment, the CPOT and BPS, are mentioned in all the research that were reviewed ***(Grosso et al., 2019)***.

The CPOT scored higher for nociceptors and non-nociceptive trials differed statistically significantly, demonstrating the appropriate discriminatory validity of the tools. This result supports the discriminant validity of the Persian CPOT, which has been found to be satisfactory in various previous studies (***Chookalayia et al., 2018***), (***Rafiei et al., 2016***). Results also indicated that the CPOT's effects size in discriminating between nociceptors and non-nociceptive processes was fairly tiny, indicating that the tool's discriminant validity was limited ***(Grosso et al., 2019).***

The satisfactory discriminant validity of the measure was further confirmed by the discovery of a notable difference between the average BPS scorings obtained throughout nociceptors and non-nociceptive protocols. The scale's difference between these two processes had a relatively tiny effect size, nevertheless. The survey's main weakness was the paucity of information about the psychometric characteristics of these tests amongst individuals with altered consciousness ***(Grosso et al., 2019).***

Post-cardiac surgical sufferers have also been investigated to determine the BPS's validity. In a prospective observational cohort survey performed in 2018, Kotfis et al analyzed the usage of the BPS in postoperatively cardiac surgery individuals who were both sedated with dexmedetomidine and un-sedated. They were noted at remainder, throughout a nociceptors process (positions changes), and 10 minutes after interventions. The report's objective was to validate the Polish variation of BPS (POL-BPS) in a research that included a homogeneous grouping of individuals having heart surgery under repeated intraoperative and postoperative circumstances. Furthermore, either with or without sedation, we have demonstrated good discriminant validity, as evidenced by greater BPS findings throughout painful procedures than at the period before or after these processes. These findings show that the POL-BPS is an accurate tool for measuring pain. The investigation was limited by the fact that it was an observational research undertaken on a particular population of patients, post-cardiac surgical patients and critically ill individuals who were mechanically ventilated. This showed that not all prospective critically ill individuals were included in this validation study, indicating that additional research may be needed to address particular populations (trauma, burn, children, etc.). To ensure the homogeneity of the populations being studied, we omitted emergency patients, however it is necessary to evaluate the BPS instrument in this population of patients as well ***(Kotfis et al., 2018).***

Inter-rater Reliability

When two evaluators agreed on an assessment, it is said to be inter-rater reliable. The k factor, which has a scoring between Zero and one, assesses inter-rater reliability.Analysis of dataset from 390 assessments revealed a Cohen's Kappa range of 0.450 to 0.795 ***(Fröhlich et al., 2020).***

Nazari, et al, 2022 ***(Nazari et al., 2022)*** conducted a cross-sectional research in Forty-five unconscious patients that assessed the discriminating validity and the inter - rater reliability of CPOT and BPS in the same cohort of unconscious patients in Intensive care unit. The CPOT ratings considerably rose when shifting positions but did not alter when non-invasive heart rate was measured, demonstrating the device's discriminant validity (***Rafiei et al., 2016***).

According to the study done by Kotfis et al., 2018, the POL-BPS study's findings revealed extremely high intra - subject correlations (ICC>0.86), showing the POL-BPS has very good inter-rater reliability (***Kotfis et al., 2018***).

Li et al. contrasted the CPOT, FLACC, and NPVS pain measures in the demographic of severely ill patients following heart surgery. In a cardiac post-anesthesia department, they conducted a descriptive multiple baseline research with 24 nonverbal, severely ill patients (n = 24) (***Li et al., 2009)***.

Data was gathered prior to, immediately following, and 20 minutes following two traumatic occurrences including suctioning and repositioning. With a Cronbach's alpha of 0.89, the outcomes demonstrated that both CPOT and NPVS exhibited good reliability, while CPOT had the greatest inter-rater reliability when comparing to FLACC and NPVS. The following are the nursing suctioning and repositioning approval ratings for each instrument: CPOT received a score of 80% for suction tube and 85% for repositioning; NPVS received a score of 78% for suctioning and 79% for repositioning; and FLACC received a score of 78% for suctioning and 84% for refocusing (***Li et al., 2009***).

In comparison to NPVS and FLACC, the authors found that CPOT is a more effective method for assessing pain in post-open cardiac surgical patients on mechanical ventilation ***(Li et al., 2009).*** Using a convenience samples, the using of pain evaluations only through the day shifts, and the generalization of these results from post-cardiac surgical individuals to all other Intensive Care Unit patients were all limitations of this survey (***Li et al., 2009***).

Rijkenberg et al. (2015) evaluated the psychometric characteristics of the two greatest widely used behavioral pain rating scales, the CPOT and BPS, for ventilated patients who were non-verbal. In a mixed-adult Intensive care unit medical center in the Netherlands, researchers performed a prospective observation cohort research on 68 ventilated patients. At four different intervals, the BPS and CPOT were conducted in parallel and completely independent: just before a non-painful process, during the non-painful process, just before a painful surgery, and during the invasive procedure. Rotation was employed as a painful operation, while oral caring was utilized as a non-painful technique. The nurses for the paired evaluations were not chosen randomly, and all four evaluations took place on the same day from 4 am to 10 am. The usage of BPS and CPOT was taught to every ICU nurse, and a month-long trial run was accomplished ***(Rijkenberg et al., 2015).***

The intra-class correlations coefficient for the CPOT was 0.75, with a 95% confidence interval, showing indications of inter-rater dependability. BPS rating intra-class correlations was 0.74, with a 95% confidence interval, and a P value of 0.001. When using BPS and the same CPOT ratings, there was a considerable rise in pain levels between rest and non-painful procedures. The investigators came to the conclusion that CPOT was preferable to BPS for pain evaluation in elderly patients on mechanical ventilators in the ICU as a result of this raising the issue of the discriminant validity of the BPS (***Rijkenberg et al., 2015***). The research has two limitations: BPS was always finished first, and dental care for non-painful procedures might have had an impact on how the pain scaling's element measuring facial expressions was assessed. The researchers also discovered that BPS and CPOT analyses were carried out using a Dutch version of the instruments that had been developed by a team of medical personnel and skilled English language interpreters, while instruction for the English versions of the instruments was done for those used for BPS and CPOT. The report's other shortcomings include the small number of participants, the fact that the nurses were not blinded to the treatments, and the existence of delirium, which might have affected the patients' actions linked with pain (***Rijkenberg et al., 2015)***.

In the study by Papakitsos et al. (2015), the averaged kappa correlations were used to determine inter-rater reliability for a sum of 258 coupled pain evaluations through using 3 distinct pain measures. In comparison to NVPS (0.71+/-0.04), the adjusted kappa values for CPOT and BPS were 0.81 +/- 0.03 and 0.71 +/- 0.04 respectively. This result demonstrated nearly flawless inter-rater reliability for CPOT and BPS ***(Papakitsos, Kapsali, & Papakitsou, 2015)***. Kanji et al. observed identical results with high inter-rater reliability ***(Kanji et al., 2016)*** with k of 0.669 and inter-class correlations r of 0.957 in the non - verbal Intensive care unit patients with delirium. Gélinas, Arbour, Michaud, Vaillant, and Desjardins (2011) (***Gélinas et al., 2011***)also discovered inter-rater reliability scores ranging from 87% to 100% for 29 nursing members tested at 12 months after the CPOT evaluation tool's deployment.

Internal Consistency

The degree of consistency between the findings for several subdomains of the same concept is measured by internal consistency. Through the use of the Cronbach-a technique, the internal consistency of the CPOT has been assessed by numerous researches. A Cronbach-a rating of 0.7 or greater supports the tool's internal consistency and exhibits strong interdependence among its several areas ***(Papakitsos et al., 2015).*** With such a Cronbach-a value of 0.81 for CPOT as opposed to 0.80 for BPS and 0.76 for NVPS, there was a good value of internally consistency (***Papakitsos et al., 2015***). Likewise, Kanji et al. (2016) **(Kanji et al., 2016)** achieved a total Cronbach's alpha of 0.778 for the use of the CPOT in delirious Intensive Care Unit patients whereas Rijkenberg et al (2015) ***(S Rijkenberg et al., 2015)*** discovered satisfying internally consistency of Cronbach a scorings of 0.71 all through painful procedure for CPOT in comparison to 0.70 for BPS. These investigations provide extensive proof of the strong association between the four CPOT instrument domains.

Sensitivity and Specificity

For non-verbal individuals on a ventilator, treatments for pain treatment typically entail large dosages of injectable painkillers like Fentanyl and Hydromorphone. Consequently, it is important to utilize a painful evaluation measure that has high specificity and sensitivity in addition to being credible and accurate. A high specificity number means that pain ratings accurately reflect pain and do not also account for other illnesses like delirium or psychosis. It lowers the incidence of diagnosing pain incorrectly and will stop overmedicating for pain. High sensitivity values mean that no pain events will go unnoticed or unidentified. This reduces the possibility of inaccurate negatively appraisals and gives sufferers access to effective pain therapy.

Gélinas et al. (2009) quite far explored the sensitivity and specificity of the CPOT in elderly ventilator individuals after heart surgeries. They assessed 105 individuals over the course of three months, comparing pain at resting (pre-exposure), during the unpleasant relocation operation (exposures), and twenty minutes thereafter (post-exposure). To reduce bias, CPOT pain evaluations were finished first. The subjects were requested to nod if they were in pain or not before being prompted to rate their discomfort using the Descriptive Pain Scalngi or the Faces Pain Thermometer. The scientists determined that throughout painful procedures, CPOT had a high sensitivity score of 86 percent and a specificity rating of 78 percent. For post-exposure, the sensitivity and specificity reached 63 and 97.4 percent, respectively. Pre-exposure specificity was 82.9 percent, but sensitivity was only 47.2 percent. This could mean that CPOT is less successful at detecting mild or moderate basal pain in patients recovering from post cardiac operations. Additional research with multiple diagnostic demographics is required to determine the sensitivity and specificity of the CPOT (***Gélinas et al., 2009***).

2.6.4. Clinical Outcomes after CPOT implementation

For non-communicative individuals who received mechanical ventilation, additional researches and investigations have led to the identification of valuable and efficient pain assessments methods. Nevertheless, few researchers have examined into how using the CPOT or BPS scales affects pain treatment and clinically results. Theoretically, an efficient pain evaluation method could perhaps enhance nursing pain control techniques, deliver better pain medication, reducing the quantity of sedation required, which in turn must reduce delirium, increase compliance with mobility instructions, decrease the number of days spent on a ventilator thanks to better compliance with ventilator weaning, and minimize duration of stay in the intensive care unit (ICU). Further research is required to determine whether or not this idea is correct ***(Darmanto et al., 2020).***

The first research evaluating the impact of using the CPOT on painful managements and clinically outcomes in mechanically ventilated trauma Intensive care unit victims was carried out by Arbour et al. in 2011. With a random sample hospital records, including 15 pre- and 15 post-CPOT installation files, they conducted a pilot pre-experimental both during analysis. A 90-minute retraining sessions was conducted for nurses, and the ICU nurses flow sheets incorporated CPOT. Scientists determined that the incidence of pain episodes was 4 times greater in the post-implementation cohort than in the pre-implementation category, and that pain was evaluated three times more frequently in the post-implementation cohort. In comparison to the pre-implementation category, additional analgesics and prescribed dosages of analgesics were administered in the post implementation cohort. Pre-implementation participants took sedatives or protocol up to twice as frequently as post-implementation participants. In the post-implementation cohort, nursing documented pain evaluation levels at a ratio of 93.3% versus 40% in the pre-implementation cohort. Although more analgesics were given in the post-implementation, pharmaceutical therapies also showed improved efficacy (***Arbour, Gélinas, & Michaud, 2011)***.

Complications decreased from an average of 4.53 prior to implementation to 1.87 following it and Intensive care unit LOS decreased from an average of 10.53 prior to implementations to 5.33 following it. Ventilator days decreased from 6.93 days prior to implementations to 4 days after implementations, but no statistically significant change was identified (***Arbour et al., 2011***). The report's limitations included a small samples and a homogeneous cohort of solely trauma patients that limited its capacity to generalize to the entire Intensive care unit cohort. The use of different techniques in the other ICUs may have produced different outcomes due to the nurses' knowledge with CPOT. Another drawback was that different patients had different routines for ordering their medications, which may have had an impact on how effective the drug therapies were (***Arbour et al., 2011***).

A before-and-after analysis was also carried out by Gélinas, Arbour, Michaud, Vaillant, and Desjardins (2011) to analyses the impact of CPOT adoption on nurses' management of pain and pain treatment techniques. They examined 30 patient records prior to implementations, 30 more at three months after implementations, and thirty more at twelve months after implementations (***Gélinas et al., 2011)***.

The assessment of pain reporting, pain-related behaviors, analgesic and sedative administrations, and reporting on the efficiency of pharmacologically treatments were finished. Findings demonstrate that compared to pre-implementation findings of 3 evaluations in a 24-h cycle, post-implementations reports of pain had jumped to 10.5 tests in that time. The study conducted 12 months after implementations also revealed significantly more reportings of discomfort at 12 examinations over 24 h periods, that was around four times the rate before implementations. The levels of pain reevaluation following the pharmaceutical treatment also improved, rising from 9.92% before to deployment to 43.1% at 3 months and 59.1% at 12 months. The efficacy of pain management had also improved, going from 64.3 percent prior to introduction to 75 percent at 3 months and 80.8 percent at 12 months. They also discovered a reduction in the number of sedative (Propofol) and analgesics (Buprenorphine) boluses administered during the post-implementation stage. The greater sensitivity and specificity levels of CPOT could be used to explain the rise in nursing informatics in complaints of pain and reevaluation of pain. The incidence of documenting may have been boosted by additional elements like current training and include CPOT use in the level of caring (***Gélinas et al., 2011***).

The report's limitations were that the organization had switched from being a tertiary trauma center to a secondary trauma center, which resulted in a decline in the amount of trauma patients included in the study from 9 at the pre-implementation and 3 months after adoption to 4 at twelve months. Given that trauma individuals frequently suffer greater acute pain and need more pharmaceutical therapies, this may have had an impact on the incidence and frequency of pain. Another drawback of the research was the high percentage of nursing burnout, which caused the number of qualified nurses to drop from 60 before implementations to 29 after implementations (***Gélinas et al., 2011***).

For efficient pain measurement, the CPOT or BPS are suggested by the most recent Pain, Agitation, Delirium (PAD) guidelines from SCCM (***Gomarverdi et al., 2019***). The validity and reliability of the CPOT and BPS pain measures in a variety of patient demographics receiving intensive caring, including those with trauma, clinical, neurosurgery, cardiac operations, and dementia, have been established via several research investigations. The relationship between the usage of the CPOT and good diagnostic results, including as death, complications, patient satisfactions, LOS, delirium, chronic pain, and post-ICU syndromes, is still not fully understood. There is a need for more randomized clinical research to examine the effects of accurate pain management on outcome measures (***Georgiou et al., 2015)***.

Chapter Three

Patients and methods

3.1. Research Design

Experimental Quasi study, cross-sectional study design to compare of the BPS and CPOT scale in detecting patient's pain pre & post invasive procedures of ICU & Comparison of pain intensity in some certain procedures such as tracheal secretion suctioning, respiratory physiotherapy, administrating medication, Peripheral Intravenous Line Placement, Oral Endotracheal Intubation, Peripherally Inserted Central Catheter and Midline Catheter by two study scales

Data collection will be through The Behavioral Pain Scale "BPS" and Critical Care Pain Observation Tool "CPOT" to measure pain in patients

The expected outcomes of this study may indicate comparison of the Behavioral Pain Scale and the Critical-Care Pain Observation Tool in Assessing Pain in Mechanically Ventilated Critical Care Patients

Measure the appropriateness of two behavioral scales, the Behavioral Pain Scale and the Critical Care Pain Observation Tool, for pain assessment in mechanically ventilated patients admitted to intensive care units

3.2. Instruments

The study design will be experimental, cross sectional study. Data will collect by utilizing a COPT scale & BPS to measure pain in mechanically ventilated patients in

ICU wards. Using this design to achieve the purpose of the study which is to assess the pain of patients admitted in ICU at Jenin & Rafidea Hospitals.

Pretest procedure post procedure test design will be performed to evaluate the effectiveness of the CPOT & BPS.

In this study, a questionnaire will be consisting of the following parts:

Section I: Demographic Variables: The demographic variables of the participants will include age, Occupation, Education status, Type of Family, place of residence, and Duration of hospital stay.

Section II: COPT Scale: The CPOT was created to appraise pain in patients who are unable to self-report the presence of pain. It consists of four behavioral indicators of pain: facial expression, body movements, compliance with the ventilator for intubated patients or vocalization for extubated patients, and muscle tension. Each category is scored from 0-2 points with a maximum total score of 8 points.

A CPOT total score of less than or equal to a score of 2 points suggests there is no pain, while a score of 3-8 points indicates the presence of pain. If a CPOT total score ≥ 3 points is evident, pain management is recommended.

Section III: The BPS Scale

The BPS was developed by Paten et al. in order to assess pain in unconscious mechanically ventilated patients. The scale is based on three types (ranges) of behaviour: 1) facial expressions, 2) movements of the upper extremities and 3) compliance with a ventilatory. The observer scores each range; the total score varies from 3 (no pain) to 12. The available study findings demonstrate that the BPS has good psychometric properties and moderate/high indices of interobserver agreement.

Sample will be ventilated patients in ICU at Al Jenin & Rafidea Hospitals who has Laparotomy surgery, Subarchnoid Hemorrhages & Road Traffic Accidents who received morphine, Fentanyl & Paracetamol pain control medications according to the intensity of pain.

3.3. Test Procedure and Scoring Instructions

1. Observe patient. Is the patient alert and calm? (score 0)

a. Does patient have behavior that is consistent with restlessness or agitation? (score +1 to +4 using level criteria)

2. If patient is not alert, in a loud speaking voice state patient's name and direct patient to open eyes and look at speaker. Repeat once if necessary. Can prompt patient to continue looking at speaker.

a. Patient has eye opening and eye contact, which is sustained for more than 10 seconds (score −1).

b. Patient has eye opening and eye contact, but this is not sustained for 10 seconds (score −2).

c. Patient has any movement in response to voice, excluding eye contact (score −3).

3. If patient does not respond to voice, physically stimulate patient by shaking shoulder and then rubbing sternum if there is no response to shaking shoulder.

a. Patient has any movement to physical stimulation (score −4). b. Patient has no response to voice or physical stimulation (score −5).

3.4. Sample of the study:

Thirty patients were admitted to the ICUs of Rafedia Governmental & Jenin Hospitals in North West Bank during 3 months.

Admission diagnosis was:

- Subarachnoid Hemorrhage
- Laparotomy
- Resp. Comp
- Gastrointestinal Comp,
- Cardio/ Vasc. Comp
- Acute kidney failure
- Liver Failure

3.5. Setting and participants

Convenient sampling method was used to select the study participants. 30 patients who were admitted in ICU during the study period at Jenin & Rafedia governmental hospitals

3.6. Validity

Both the CPOT and BPS were developed to assess pain in ICU patients unable to self-report. The CPOT consists of four behavioral items: 1) facial expressions, 2) body movements, 3) compliance with the ventilator (intubated patients) or vocalization (nonintubated patients), and 4) muscle tension. Each behavioral item is scored on a scale from 0 to 2. BPS is composed of three behavioral items: 1) facial expression, 2) movements of upper limbs, and 3) compliance with the ventilator. Each behavioral item is scored on a scale from 1 to 4.

The validation testing was performed in ICU patients when exposed to two procedures: 1) standardized by nociceptive-stimulation by pressure algometry and 2) standard care (turning). The validation study phases are included seven assessments.

3.7. Reliability

Cronbach's Alpha was calculated for BPS and CPOT scales. Cronbach's Alpha for BPS was 0.95 and 0.91 for CPOT scale.

3.8. Period of study

The targeted participants of the study will be all patients admitted in ICU in Jenin & Rafidea Hospitals. In the period 1 JUNE TO 1 JULY

3.9. Study procedure and data collection

Certain pain conditions were selected to minimize the impact of daily care procedures on patients' pain response because patients reported different pain intensities pre and post different procedures. Body temperature monitoring was chosen as a low pain condition both for nonintubated patients and intubated patients. Position changing and endotracheal suctioning were, respectively, chosen as an increased pain condition for nonintubated and intubated patients.

Patients will be observed by COPT in the low pain condition. The COPT scores were also acquired during the increased pain condition. All of these assessments were completed by a researcher in the first study in pre implementation of any invasive procedures, during and after the implementation of procedures. A half hour training course for the nurses in ICU in how to use CPOT for pain assessment will be provided to the bedside nurse. Then, the bedside nurse and a researcher evaluated each of the patients with CPOT during the low pain condition and the increased pain condition, independently and synchronously, without communication to each other.

3.10. Ethical considerations

As the research was involving human participants, it was necessary to follow strict ethical principles. After obtaining approval from Arab American University and Jenin & Rafidea Hospitals Administration, the questionnaire will be completed by the researcher at Jenin & Rafidea Hospitals. These questionnaires will be attached with a cover paper including the purpose of the study, participation instructions, consent form, and an empty envelope to use it after filling the questionnaire.

Ethical approval will be obtained from Arab American University, Jenin & Rafidea Hospitals Administration. Consent form will be provided for every participant prior to the study. Voluntary participation will be explained to the patients or his family. No names will be mentioned or any personal information about the participant. All data will be kept confidential and will be used for study purposes only. No any harms of consequences due to participation refusal such as care quality or privileges. Clear explanation will be given to each participant bout the study objectives and tool, enough time will be given for questions

Participant confidentiality was assured through restriction of data access and no use of identifying information. Only the nurse researcher has access to the data. All data was locked and secured in a file cabinet. All data will be destroyed once the study is complete

Anonymity was maintained by numbering the participants and by destroying the names attached to the numbers after the researcher went back to a few participants to validate the transcriptions. Confidentiality was ensured by guiding against unauthorized access to the data.

All family participants were informed about the purpose and design of the study and were told that they were free to withdraw from the study any time. The interviews were held at the end of the academic term after students' grades were announced.

The inclusion criteria will include who are: All patients in ICU in Jenin & Rafidea Hospitals during a period will be defined later and accepted to participate on this study.

The exclusion criteria

will include who are :

1. Patients age less than 18 year.

Inclusive Criteria

1. are aged over 18 years
2. have the ability to communicate
3. have provided written informed consent, and

4. have healthy, intact facial skin. Participants will be excluded if they have (1) any diagnosed condition affecting cognitive functions (e.g., dementia, psychosis), (2) hand deformities that prevent the sensor from being placed, (3) any diagnosed condition affecting the central nervous system, or facial nerves or muscles, or (4) significant facial hair growth in the area where the sensors will be attached.

Chapter Four

Results

4.1. Introduction

This chapter deals with the data collected for analysis. The statistical method allowed the investigator to deduce, analyze, coordinate, measure, evaluate and convey the numerical information. The aim of data analysis is to provide answers to questions about the study. The data analysis strategy comes directly from the question, the design and the data collection process and the level of measurement of the data. This chapter edits, tabulates, analyzes and interprets the data collected.

This chapter expresses the findings concerning to compare of the BPS and CPOT scale in detecting patient's pain pre-during & post invasive procedures of ICU. Statistical analyses were directed to explore three research questions:

1. What is the level of intubated patients' pain based on BPS and CPOT scales in the ICU?
2. Are there correlation between BPS and CPOT measurements before pain procedures for intubated patients in the ICU?
3. Are there correlation between BPS and CPOT measurements after pain procedures for intubated patients in the ICU?

4.2. Reliability of the Scales

Cronbach's Alpha was calculated for BPS and CPOT scales. Cronbach's Alpha for BPS was 0.95 and 0.91 for CPOT scale.

4.3. Participants' Characteristics

Thirty patients were admitted to the ICUs of Rafedia Governmental & Jenin Hospitals in North West Bank during 3 months.

The findings revealed that the mean age of patients was 48.4 (14.3). The majority of them were male19 (63.3%) and smokers. Also, the mean of the BMI of the participants was 28.3 (SD= 4.0). The demographic characteristics of the patients are presented in Table 4.

Table (4): Demographic characteristics of the participants (N=30)

Characteristics		M (SD)	N (%)
Age		48.4(14.3)	
Gender	Male		19(63.3)
	Female		11(36.7)
Smoking	Yes		19(63.3)
	No		11(36.7)
BMI		28.3(4.0)	

4.4. Medical history of the Participants

The findings revealed that more than half of the patients 17 (56.7%) were diagnosed with subarachnoid hemorrhage. One third of them 10(33.3%) had both subarachnoid hemorrhage and respiratory compromise when they admitted to ICU. Also, 10(33.3%) with free past history. Less than half of them 14(46.7%) have DM type 2. Most of them 24 (80.0%) were unconscious when they admitted to ICU. In addition, 12(40.0%) of them were on pressure SIMV. Furthermore, 23 (76.7%) of the patients were assessed by Visual analogue scale (VAS). The medical history of the patients are presented in Table 5.

Table (5): Medical history of the participants (N=30)

Item		M (SD)	N (%)
Admission diagnosis	Subarachnoid Hemorrhage		17(56.7
	Laparotomy		13(43.3
Length of Mechanical Ventilation /days		10.2(9.1)	
ICU length of stay/ days		10.9(9.3)	
Level of Consciousness at the time of ICU admission	Unconscious (Glasgow ≤ 8)		24 (80)
	Conscious (Glasgow ≥ 9)		6(20)
Mode of ventilator	Pressure A/C		5(16.7)
	Volume A/C		5(16.7)
	Volume SIMV		2(6.7)
	Pressure SIMV		12(40.0)
	CPAP		6(20.0)
Pain assessment scale used in the hospital	Visual analogue scale (VAS)		23(76.7)
	Critical care observation tool (CPOT)		7(23.3)
ICU admission diagnosis	Resp. Comp		2(6.7)
	Gastrointestinal Comp		5(16.7)
	Subarachnoid Hemorrhage		5(16.7)
	Resp. Comp and Subarachnoid hemorrhage		10(33.3)
	Resp. Comp and Gastrointestinal Comp.		3(10.0)
	Cardio/ Vasc. Comp & Gastrointestinal Comp		1(3.3)
	Resp. Comp, Gastrointestinal Comp. & Liver Failure		2(6.7)
	Resp. Comp & Acute kidney failure		1(3.3)
	Resp. Comp, Subarachnoid hemorrhage, Liver failure		1(3.3)

4.5. Participants' pain before pain procedure

The characteristics of the BPS and CPOT description before pain procedures can be seen in Table 6.The BBS description revealed that in Applied cannula, Secretion suctioning, Changing position, and Needle stick procedures, the sample 18(60.0%), 23(76.7%), 24(80.0%), 24(80.0%)was dominated by painless respectively. Similarly, the CPOT description revealed that in Applied cannula, Secretion suctioning, Changing position, and Needle stick procedures, the sample Painless 18(60.0%) 23(76.7%), 24(80.0%), and 23(76.7%) was dominated by painless respectively.

Table (6): Characteristics Description of the BPS and CPOT before procedures

		Applied cannula N(%)	**Secretion suctioning N(%)**	**Changing position N(%)**	**Needle stick N(%)**
BPS	Painless (3)	18(60.0)	23(76.7)	24(80.0)	24(80.0)
	mild pain (4–6)	5(16.7)	4(13.3)	5(16.7)	5(16.7)
	Moderate pain (7–9)	3(10.0)	2(6.7)	0	1(3.3)
	severe pain (10–12)	4(13.3)	1(3.3)	1(3.3)	0
CPOT	Painless (0)	18(60.0)	23(76.7)	24(80.0)	23(76.7)
	Mild pain (1-3)	5(16.7)	4(13.3)	5(16.7)	6(20.0)
	Moderate pain (4-6)	6(20.0)	3(10.0)	0	1(3.3)
	Severe pain (7-8)	1(3.3)	0	1(3.3)	0

Assessment of vital signs before pain procedures can be seen in Table 7. The mean of the Vital signs measurements revealed that approximately similar for applied cannula, Secretion suctioning, Changing position, and Needle stick procedures.

Table (7): Assessment of vital signs before pain procedures (n=30)

Procedure	Systolic B/P	Diastolic	MAB	Pulse	Respiration	Temp
	M(SD)	M(SD)	M(SD)	M(SD)	M(SD)	M(SD)
Applied cannula	134.8 (20.0)	65.1(12.2)	74.2(13.5)	77.4(22.9)	15.4(3.1)	36.2(0.8)
Secretion suctioning	131.4 (19.7)	65.7(12.6)	74.7(13.1)	76.2(14.2)	15.9(3.5)	36.3(.8)
Changing position	131.0 (18.8)	65.3(12.3)	72.0(13.1)	74.1(15.0)	15.5(3.1)	36.3(.8)
Needle stick	129.4 (18.3)	66.6(12.1)	75.8(14.1)	74.3(15.5)	15.6(3.2)	36.3(.8)

Pearson correlation test was performed between both BPS and CPOT before pain procedures. The analysis revealed that the BBS and CPOT were strongly correlated in applied cannula, Secretion suctioning, Changing position, and Needle stick procedures (0.962. 0.939, 0.988, 0.985) at $p < 0.001$ respectively. The correlation of the BPS and CPOT before pain procedures can be seen in Table 8.

Table (8): Correlation between mean pain scores before different procedures [measured by BPS and CPOT scale (n=30)

Procedure	BPS M(SD)	CPOT M(SD)	Statistic	P Value
Applied cannula	4.9(2.8)	1.5(2.2)	.962	0.001
Secretion suctioning	3.9(1.9)	.8(1.5)	.939	0.001
Changing position	3.6(1.5)	.7(1.6)	.988	.001
Needle stick	3.4(1.1)	.5(1.3)	.985	.000

4.6. Participants' pain after pain procedure

The characteristics of the BPS and CPOT description after pain procedures can be seen in Table 9. The BBS description revealed that in Applied cannula, changing position, and Needle stick procedures, the sample 10(33.3%), 14(46.7%), 17(56.7%) was dominated by painless respectively. However, the BBS description in secretion suctioning procedure revealed that the sample 23(76.7%) was dominated by severe pain.

On the other hand, the CPOT description revealed that in Changing position and Needle stick procedures, the sample Pain 14(46.7%) and 17(56.7%) was dominated by painless respectively. However, the CPOT description in secretion Applied cannula and Changing position procedures revealed that the sample 13(43.3%) and 20(66.7%) was dominated by moderate pain.

Table (9): Characteristics Description of the BPS and CPOT after procedures (N=30)

Pain tool	Pain level	Applied cannula N(%)	Secretion suctioning N(%)	Changing position N(%)	Needle stick N(%)
BPS	Painless (3)	10(33.3)	4(13.3)	14(46.7	17(56.7)
	mild pain (4–6)	7(23.3)	1(3.3)	7(23.3	10(33.3)
	Moderate pain (7–9)	5(16.7)	2(6.7)	7(23.3	0
	Severepain (10–12)	8(26.7)	23(76.7)	2(6.7	3(10.0)
CPOT	Painless (0)	9(30.0)	5(16.7)	14(46.7	17(56.7)
	Mild pain (1-3)	6(20.0)	1(3.3)	7(23.3	9(30.0)
	Moderate pain (4-6)	13(43.3)	20(66.7)	8(26.7	4(13.3)
	Severe pain (7-8)	2(6.7)	4(13.3)	1(3.3	0

Assessment of vital signs after pain procedures can be seen in Table 10. The mean of the Vital signs measurements revealed that approximately similar for applied cannula, Secretion suctioning, Changing position, and Needle stick procedures.

Table (10): Assessment of vital signs after different procedures (N=30)

Procedure	Systolic B/P	Diastolic	MAB	Pulse	Res.	Temp
	M(SD)	M(SD)	M(SD)	M(SD)	M(SD)	M(SD)
Applied cannula	140.0(22.7)	66.4(13.5)	77.4(13.7)	80.4(16.4)	17.0(4.8)	36.3(.8)
Secretion suctioning	147.1(23.0)	72.0(15.3)	80.8(15.3)	90.0(17.0)	18.4(5.1)	36.3(.8)
Changing position	136.8(20.7)	67.8(11.9)	76.4(13.0)	78.6(15.0)	16.2(3.8)	36.3(.8)
Needle stick	135.1(20.3)	67.0(13.4)	77.8(22.6)	77.8(15.7)	16.3(3.6)	36.3(.8)

Pearson correlation test was performed between both BPS and CPOT after pain procedures. The analysis revealed that the BBS and CPOT were strongly correlated in applied cannula, Secretion suctioning, changing position, and Needle stick procedures (0.838, 0.838, 0.987, and 0.968) at $p < 0.001$ respectively. The correlation of the BPS and CPOT after pain procedures can be seen in Table 11.

Table (11): Correlation between mean pain scores after different procedures measured by BPS and CPOT scale (N=30)

Procedure	**BPS M(SD)**	**CPOT M(SD)**	**Statistic**	**P Value**
Applied cannula	6.5(3.2)	3.1(2.5)	.838	.001
Secretion suctioning	9.2(2.7)	4.5(2.3)	.838	.001
Changing position	5.6(2.9)	2.1(2.2)	.987	.001
Needle stick	4.5(2.3)	1.4(1.8)	.968	.001

Chapter Five

Discussion

Pain management is an integral part of nursing care to optimize the quality of life and survival of patients. Inadequate knowledge and malpractice of pain management are well-cited clinician-related barriers in care place.

Implementing the CPOT can lead to a significant difference in the amount and frequency of administered analgesics. It means using CPOT had led to a more accurate assessment of pain among hospitalized patients in the ICU.

The impact of this study could affect many patients that are unable to verbalize their pain. Assessing an accurate pain level for patients can impact the overall well-being for that patient. Untreated or undertreated pain can affect many different body systems and can ultimately lead to an increase in the length of stay. Using an accurate pain assessment tool for patients, who cannot verbalize their pain level could potentially decrease healthcare costs and an extended length of stay.

As regards the characteristics of the studied patients, the findings revealed that the mean age of patients was 48.4 (14.3). The majority of them were male19 (63.3%) and smokers. Also, the mean of the BMI of the participants was 28.3 (SD= 4.0). These results were parallel to the study done by ***Muacevic & Adler, (2021)*** who pointed out that the mean ± SD age of the patients was 55.3 ± 15.3 years, and the mean ± BMI was 26.2 ± 7.3 kg/m^2. More than half of the patients were females (53.7%) and married (89.1%).

In relation to compare between COPT & BPS in measuring pain for intubated unconscious patients at ICU, Findings revealed that BPS description revealed that in Applied cannula, Secretion suctioning, changing position, and Needle stick procedures, the sample 18(60.0%), 23(76.7%), 24(80.0%), 24(80.0%)was dominated by painless respectively. Similarly, the CPOT description revealed that in Applied cannula, Secretion suctioning, changing position, and Needle stick procedures, the sample Painless 18(60.0%) 23(76.7%), 24(80.0%), and 23(76.7%) was dominated by painless respectively. These findings were similar to the findings of Hirsch et al (2010) who studied Evaluation of nurses' self-insight into their pain assessment and treatment decisions also indicated that the behavior pain scale (BPS) training resulted in up to 76.1% increase in pain assessment by nurses. ***Sedighie et al.*** (2019) showed that the use of BPS was effective in the ability to detect and monitor pain in patients with decreased level of consciousness, who are not able to express their pain. This enables the healthcare providers to diagnose and manage pain based on the behavioral symptoms. In addition, they concluded that the use of objective indicators by ICU nurses in the process of pain assessment is necessary.

In the light of the study findings, the results of the participants' pain before pain procedure revealed that the BPS and CPOT description before pain procedures ~~can be seen in Table 4-3~~.The BBS description revealed that in Applied cannula, Secretion suctioning, Changing position, and Needle stick procedures, the sample 18(60.0%), 23(76.7%), 24(80.0%), 24(80.0%) was dominated by painless respectively.

Similarly, the CPOT description revealed that in Applied cannula, Secretion suctioning, Changing position, and Needle stick procedures, the sample Painless 18(60.0%) 23(76.7%), 24(80.0%), and 23(76.7%) was dominated by painless respectively & the

BBS description revealed that in Applied cannula, Changing position, and Needle stick procedures, the sample 10(33.3%), 14(46.7%), 17(56.7%) was dominated by painless respectively. However, the BPS description in secretion suctioning procedure revealed that the sample 23(76.7%) was dominated by severe pain. On the other hand, the CPOT description revealed that in Changing position and Needle stick procedures, the sample Pain14 (46.7%) and 17(56.7%) was dominated by painless respectively.

However, the CPOT description in secretion Applied cannula and Changing position procedures revealed that the sample 13(43.3%) and 20(66.7%) was dominated by moderate pain. These findings were in agreement with the study done by ***Kobayashi et al., (2019)*** who studied Arterial blood pressure correlates with 90-day mortality in sepsis patients: a retrospective multicenter derivation and validation study using high-frequency continuous data which concluded that severely ill adult patients experience moderate-to-severe pain at rest and during procedures of standard care; intense pain can have adverse effects, such as cardiac and respiratory failure.

Currently, an objective index, such as CPOT, is used when an ICU patient cannot express pain; however, continuous evaluation is difficult because of the patient's condition. Particularly, during the night or when the staff is busy, pain evaluation and care tend to be delayed. As stated by ***Birkedal et al., (2021)*** in a study about comparison of two behavioral pain scales for the assessment of procedural pain: A systematic review which concluded that the potential range of pain scores on the CPOT was 0 to 8. Eighty-five total assessments were conducted and the CPOT was also measured when patients were at rest, following a normal noninvasive blood pressure check, and after turning. CPOT scores ranged at rest from 0 to 6. CPOT scores ranged after a normal blood pressure check from 0 to 6. BPS scores ranged after turning from 0 to 9. The results suggest that the average CPOT scores did increase from initial resting scores following turning, which is known to be a painful procedure. Statistically significant relationships were found between the BPS and CPOT scores. BPS and CPOT scores had positive high correlations at each level of pain assessment. The correlation strengthened following turning indicating that both pain assessment tools do tend to increase and reflect sensitivity.

The study's findings indicate that Pearson correlation test was performed between both BPS and CPOT after pain procedures. The analysis revealed that the BBS and CPOT were strongly correlated in applied cannula, Secretion suctioning, changing position, and Needle stick procedures (0.838, 0.838, 0.987, and 0.968) at $p < 0.001$ respectively. The correlation of the BPS and CPOT after pain procedures. These findings were similar to the results of ***Wongtangman et al (2017)*** study about Validation of the Thai Version Critical Care Pain Observation Tool and Behavioral Pain Scale in Postoperative Mechanically Ventilated ICU Patients, they concluded that the inter-rater reliability of the CPOT and BPS between two nurses was excellent, as supported by high intra-class correlation coefficients and satisfactory internal consistency. These parameters indicate that both scores produce consistent scores from different assessors.

In relation to the characteristics of the BPS and CPOT description after pain procedures. The BBS description revealed that in Applied cannula, Changing position, and Needle stick procedures, the sample 10(33.3%), 14(46.7%), 17(56.7%) was dominated by painless respectively. However, the BPS description in secretion suctioning procedure revealed that the sample 23(76.7%) was dominated by severe pain. On the other hand, the CPOT description revealed that in Changing position and Needle stick procedures, the sample Pain14 (46.7%) and 17(56.7%) was dominated by painless respectively.

However, the CPOT description in secretion Applied cannula and Changing position procedures revealed that the sample 13(43.3%) and 20(66.7%) was dominated by moderate pain. These results were in an accordance with the study conducted by ***Waladani1 et al (2021)*** about the Application of Pain Scale Assessment in Patients Attached Mechanical Ventilator in Intensive Care Unit concluded that the results of the measurement of pain at rest showed that the patients experienced: no pain as much as 17 (34%), 19 mild pain (38%), moderate pain 7 (14%), severe pain 6 (12%), and very severe pain 1 (2%). The results of this study indicate that the two pain measuring instruments, namely CPOT and BPS, are compatible in assessing the level of pain in patients who are attached to a ventilator in the intensive room who are unable to report pain verbally. This can be shown from the results of the analysis of the CPOT measuring instrument at rest and which positioning is significant with a value (p = 0.009). These results explain that the CPOT gauge is able to measure the level of pain in patients on a ventilator who are unable to report pain during rest or positioning. In patients who are treated in the intensive care unit, pain is a common symptom that often appears during treatment (positioning) or at rest.

The CPOT gauge has 5 indicators (facial expression, body movement, ventilator alarm activity, speaking if the patient is extubated, and muscle tension) measurements equipped with each indicator describing the condition with a different score where there is a clearer description of each indicator. Indicators of facial expression, muscle tension and ventilator alarm activity are important indicators in assessing pain response in patients on ventilator. These criteria make it easier to assess patients in assessing the level of pain they feel. the CPOT measurement tool has significant results that can be used to measure the pain response of patients who are attached to a ventilator in the intensive room when resting and positioning. The facial expression indicator scores well in determining the pain scale.

Rijkenberg et al addressed the relationships between the Behavioral Pain Scale (BPS) and the Critical-Care Pain Observation Tool (CPOT) in assessing pain in ventilated critical care patients. Eighty-five total assessments were conducted and the BPS and CPOT were both measured when patients were at rest, following a normal noninvasive blood pressure check, and after turning. BPS mean scores ranged from 3.600 at rest, to 3.906 with a noninvasive blood pressure check, to 6.377 following turning, and CPOT mean scores ranged from 0.894 at rest, to 1.212 following a noninvasive blood pressure check, to 4.012 following turning. Only a slight increase in mean scores was found between assessments conducted at rest and following a noninvasive blood pressure check.

However, a greater increase was found between resting and turning, which supports the findings of ***Rijkenberg et al. (2017),*** whom found BPS and CPOT scores of studied patients increased by two points from rest when conducting a painful procedure. An increase in mean pain scores totals between rest and turning suggest that the tools do detect and reflect the presence of pain, as also concluded by Rijkenberg et al. (2017).

The results of our study showed that critically ill noncommunicative patients experience pain during seemingly nonpainful care procedures and even during resting. Both study scales, BPS and CPOT, demonstrated an increase in pain score from resting to turning or suctioning of endotracheal secretions. The results of the present study, in addition to the positive and strong correlation of the BPS and CPOT, indicated that despite the similarities and differences between these tools, both are suitable scales for assessing pain among critically ill patients in ICUs. These results have similarity with the results of a study by ***Gomarverdi* et al., (2019)** about comparison of Two Pain Scales: Behavioral Pain Scale and Critical-care Pain Observation Tool During Invasive and Noninvasive Procedures in Intensive Care Unit-admitted Patients**,** results showed that critically ill patients in ICU experience a different range of pain in routine daily care. BPS and CPOT scales could be used successfully for monitoring of pain in this group of patients.

This finding is consistent with the results of other studies. Both BPS and CPOT scales showed good reliability and internal consistency in ***Rijkenberg et al.*** study, but CPOT scale remained unchanged during nonpainful procedures, whereas BPS score was significantly increased at the same time. It was mentioned in previous studies that more than 50% of critically ill patients in ICU experience moderate-to-severe pain, and this is nearly consistent with our study results that median pain score of painful procedures such as suctioning of tracheal secretions was 7 and 4 for BPS and CPOT scales, respectively, which is classified in the category of moderate pain.

In another study by ***Severgini et al.,*** (2016) in comparing two scales of CPOT and BPS to assess pain in critically ill conscious and unconscious patients, it was found that CPOT and BPS scores increased during nursing care in ICU and the results were significantly correlated. This finding is consistent to our findings that a strong correlation was found between the scores of BPS and CPOT scales.

Chapter Six

Conclusion

Effective pain assessment is paramount in critically ill patients. Critically ill patients are much more vulnerable to the side effects of untreated pain, and ineffective assessment of pain is associated with negative patient outcomes

Applying CPOT as an objective mean of pain assessment was effective in improving the performance of ICU nurses in assessment and management of patients' pain. It increased the amount and frequency of analgesic administration. We can recommend that COPT is a useful tool for assessment and management of pain in ICU patients and should be implemented in all ICUs.

The use of a valid pain assessment tool is important for pain management in all critically ill patients. Clinical practice guidelines recommend the routine assessment of pain in all critically ill patients with a validated pain assessment tool. BPS and CPOT have both been validated and are recommended for pain assessment in this patient population.

Both instruments were sensitive when applied during painful procedures, showing increases in various indicators: facial expression on the Behavioral Pain Scale and muscle tension/stiffness, facial tension and ventilator tolerance/cough on the Critical-Care Pain Observation Tool, and blood pressure on both scales.

There is, however, no agreement regarding the administration of the scales in patients with different levels of consciousness, sedation and analgesia. However, it appears that the use of at least one of the scales helps to increase the frequency of assessments and, consequently, reduces the administration of analgesics and sedatives. In this regard, it is essential that health care professionals use at least one of the two analyzed scales for pain assessment in intubated patients, with the goal of improving the care provided.

Since proper detection and management of pain is crucial in critical care settings, it is necessary that valid and reliable tools be applied for this purpose. The CPOT is a valid tool for pain assessment and can be easily applied in different ICU settings.

Management of pain for adult ICU patients should be guided by routine pain assessment. Pain experienced by critically ill patients in ICUs has to be identified early in order to implement appropriate treatment. Self-assessment method is the reference standard for pain assessment in patient who can communicate reliably. In patients unable to self-report pain experiences, the behavioral scales (CPOT or BPS) are recommended. Assessment pain should not only be done at rest, but also during care procedures, before and after analgesic treatment. Adoption of well-validated pain assessment methods and a standardized organizational approach to assessment, documentation, and communication of patient pain among ICU team members improve the pain management and quality of life of patients in ICUs and after discharge, enabling them to inform one about their needs and improve their prognosis.

Implications

This study supports the utility of experimental quasi study pain scales, such as the BPS and CPOT, to evaluate pain in mechanically ventilated critically ill patients. A further research will be necessity before one of these observational pain scales could be considered a "gold standard" for pain assessment in the mechanically ventilated critically ill patient.

There is, however, no agreement regarding the administration of the scales in patients with different levels of consciousness, sedation and analgesia. However, it appears that the use of at least one of the scales helps to increase the frequency of assessments and, consequently, reduces the administration of analgesics and sedatives. In this regard, it is essential that health care professionals use at least one of the two analyzed scales for pain assessment in intubated patients, with the goal of improving the care provided.

Further comparative studies, such as this one, that evaluates the effectiveness and clinicians' evaluations of observational pain scales are paramount to promote their usage and acceptance in the medical profession.

Limitation

Of course, this study has limitations. First, this review does not address the considerations for measuring the various phenotypic manifestations of pain. Pain can be categorized according to its duration, acute or chronic, as well as other characteristics, such as breakthrough pain and episodes of acute pain that occur in the context of otherwise well-controlled, chronic pain.

Second, the pain scales used are subjective to the operator and not objective. However, only one trained assessor evaluated pain for each patient. Third, we did not found any case of delirium in our analyzed patients, and this may be due to the level of sedative drugs applied

In addition, this study did not discriminate between the choice of response scale for a single stand-alone item or for more than one item in a multi-dimensional pain inventory.

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Appendix A

تحية طيبة وبعد :

انا الطالب زياد ضراغمة طالب في الجامعة العربية الامريكية/ ماجستير طوارئ. بصدد عمل دراسة حول أداة مراقبة الألم للعناية الحرجة مقابل أداة تقييم الألم السلوكي لتقييم الألم في المرضى البالغين الخاضعين لجهاز التنفس الصناعي: منظور قائم على الملاحظة.

<u>أهداف الدراسة :</u>

1. تقييم تجربة المريض لألم ما قبل الجراحة وبعدها في أجنحة العناية المركزة الجراحية في مستشفى جنين الحكومي ومستشفى رفيديا الحكومي عن طريق قياس مقياس الألم بواسطة مراقبة الألم للعناية الحرجة
2. تقييم تجربة المريض لألم ما قبل الجراحة وبعدها في أجنحة العناية المركزة الجراحية في مستشفى جنين الحكومي ومستشفى رفيديا الحكومي عن طريق قياس مقياس الألم السلوكي
3. مقارنة مستوى الرضا عن قياس الألم لدى مرضى أقسام العناية المركزة في مستشفى جنين الحكومي ومستشفى رفيديا الحكومي

عزيزي المشترك بالبحث في حال وافقت على المشاركة في هذه الدراسة حيث أن المشاركة طوعية ولا يترتب عليها أي ضرر ، سيبقى أسمك طي الكتمان ، ما لم ينص القانون على ذلك، علما بان هذه المعلومات لن تستخدم إلا لغرض البحث العملي فقط و بدرجة عالية من السرية و الخصوصية.

Appendix B

إقرار الموافقة على المشروع البحثي

رقم المركز:

مُعرّف الدراسة: ENCORE

رقم تحديد هوية المريض لهذه التجربة: __ __ __ - __ __ __ - __ __ __

اسم الباحث/الباحث المُنسّق المحلي للموقع: ________________

أحاطني علمًا ____ بشأن الدراسة، لقد تسلّمت وقرأت المعلومات المكتوبة بالإضافة إلى إقرار الموافقة الخاص بالدارسة المُشار إليها بالأعلى، لقد أتيحت لي الفرصة للاطلاع على معلومات تفصيلية خطيًا وشفويًا حول غرض ومجرى الدراسة، والفرص، والأخطار المترتبة على المشاركة بالإضافة إلى حقوقي والتزاماتي، أتيحت لي الفرصة لطرح الأسئلة، وقُدِّمت أجوبة مرضية وشافية على هذه الأسئلة.

قد يُستخدم رقم (أرقام) الهاتف التالي للتواصل معي:

(1)

____

(2)

____

(3)

____

لقد أحطت علمًا بأن مشاركتي هي أمر تطوعي، وأنني لدي الحق في سحب موافقتي في أي وقت من الأوقات دون إبداء أي سبب، ودون تكبّد أي أضرار.

أعلن بموجب هذا موافقتي على المشاركة في الدراسة المُشار إليها بالأعلى. نعم ☐ لا ☐

المكان والتاريخ اسم وتوقيع المُشارك

المكان والتاريخ توقيع الطبيب المُبلّغ للمعلومات

Appendix C

Demographic characteristics:

Age: …………………

Gender:

- Male
- Female

BMI: …………………

Smoker:

- Yes
- No

Admission diagnosis:

……………………………………………………………………………………………

…………

Past medical & surgical history:

……………………………………………………………………………………………

…………

ICU Admission Dx(s):

- Resp. Comp
- Cardio/Vasc Comp
- Sepsis

- Encephalopathy/ Stroke
- Acute Kidney Failure
- Gastrointestinal Comp
- Subarchnoid Hemorrhage
- Liver Failure

Medical Hx of diabetes:

- Type I
- Type II

Level of Consciousness at the time of ICU admission:

- Unconscious (Glasgow ≤ 8)
- Conscious (Glasgow ≥ 9)

Mode of ventilation:

- Prussure A/C
- Volume A/C
- Volume SIMV
- Pressure SIMV
- CPAP

Length of Mechanical Ventilation (days): ……………

ICU Length of stay (days): ………

Pain assessment scale used in hospital:

- Visual Analog Scale (VAS)
- Behavioral Pain Scale (BPS)
- Critical-Care Observation Tool (CPOT)
- None

Pre-procedure (1):

# of patient : **Name of the procedure : Applied cannula** **Pain Assessment Variables**
On analgesics infusion pump : ○ Fentanyl ○ Remifentanyl ○ morphine ○ None
On sedation infusion pump : ○ Medazolam ○ Propofol ○ Dexmedetomidine ○ None
Administrations any PRN analgesics: ○ Fentanyl (IV) ○ Hydromorphone (IV) ○ Morphine (IV) ○ Hydrocodone ○ Acetaminophen

○ None
Episodes of severe pain: ○ Yes ○ No

Vital Signs

BP	Mab	Pulse	RR	Temp

Behavioral Pain Scale (BPS)

Item	Description	Score
Facial expression	"Relaxed"	**1**
	"Partially tightened (e.g., brow lowering)"	**2**
	"Fully tightened (e.g.. eyelid closing)"	**3**
	"Grimacing"	**4**
"Upper Limb movements"	"No movement"	**1**
	"Partially bent"	**2**
	"Fully bent with finger flexion"	**3**
	"Permanently retracted"	**4**
"Compliance with	"Tolerating movement"	**1**

Coughing”	“Coughing but tolerating ventilation for the most of time”	**2**
	“Fighting ventilator”	**3**
	“Unable to control ventilation”	**4**

BPS score ranges from 3 (no pain) to 12 (maximum pain)

<u>Critical Care Pain Observation Tool</u>

Indicator		**Description**	**Score**
“Facial expression”	“Relaxed, neutral”	“No muscle tension observed”	**0**
	“Tense	“Presence of frowning, orbit tightening, levator contraction, or any other change (e.g., opening eyes or tearing during nociceptive procedures”	**1**
	“Grimacing”	All previous facial movements plus eyelid tightly closed	**2**
“Body movements”	“Absence of movements or normal position”	“Does not move at all or normal position (movements not aimed toward the pain site)”	**0**
	“Protection”	“Slow, cautious movements, touching, or rubbing the pain site, seeking attention through movements”	**1**
	“Restlessness”	“Pulling tube, attempting to sit up, moving limbs,	**2**

		not following commands, trying to climb out of bed”	
“Compliance with the ventilator (intubated patient) or Vocalization (non-intubated patient)”	“Tolerating ventilator or movement”	“Alarms not activated, easy ventilation”	**0**
	“Coughing but tolerating”	“Coughing, alarms may be activated”	**1**
	Fighting ventilator”	“Asynchrony: blocking ventilation, alarms frequently activated”	**2**
“Vocalization”	“Talking in normal tone or no sounds	“Talking in normal tone or no sound”	**0**
	“Sighing, moaning”	“Sighing, moaning”	**1**
	“Crying out, sobbing”	“Crying out, sobbing”	**2**
“Muscle tension Evaluation by passive flexion and extension of upper limbs (in rest or when patient is being turned)”	“Relaxed”	“No resistance to passive movement”	**0**
	“Tense, rigid”	“resistance to passive movements”	**1**
	“Very tense or rigid”	“Strong resistance to passive movements, inability to complete them”	**2**

Post-procedure (1):

# of patient : **Name of the procedure : Applied cannula** **Pain Assessment Variables**
On analgesics infusion pump : ○ Fentanyl ○ Remifentanyl ○ morphine ○ None
On sedation infusion pump : ○ Medazolam ○ Propofol ○ Dexmedetomidine ○ None
Administrations any PRN analgesics: ○ Fentanyl (IV) ○ Hydromorphone (IV) ○ Morphine (IV) ○ Hydrocodone ○ Acetaminophen ○ None
Episodes of severe pain: ○ Yes ○ No

Vital Signs

BP	Mab	Pulse	RR	Temp

Behavioral Pain Scale (BPS)

Item	Description	Score
Facial expression	"Relaxed"	**1**
	"Partially tightened (e.g., brow lowering)"	**2**
	"Fully tightened (e.g.. eyelid closing)"	**3**
	"Grimacing"	**4**
"Upper Limb movements"	"No movement"	**1**
	"Partially bent"	**2**
	"Fully bent with finger flexion"	**3**
	"Permanently retracted"	**4**
"Compliance with Coughing"	"Tolerating movement"	**1**
	"Coughing but tolerating ventilation for the most of time"	**2**
	"Fighting ventilator"	**3**
	"Unable to control ventilation"	**4**

BPS score ranges from 3 (no pain) to 12 (maximum pain)

Critical Care Pain Observation Tool

Indicator		Description	Score
"Facial expression"	"Relaxed, neutral"	"No muscle tension observed"	**0**
	"Tense"	"Presence of frowning, orbit tightening, levator contraction, or any other change (e.g., opening eyes or tearing during nociceptive procedures"	**1**
	"Grimacing"	"All previous facial movements plus eyelid tightly closed"	**2**
"Body movements"	"Absence of movements or normal position"	"Does not move at all or normal position (movements not aimed toward the pain site)"	**0**
	"Protection"	"Slow, cautious movements, touching, or rubbing the pain site, seeking attention through movements"	**1**
	"Restlessness"	"Pulling tube, attempting to sit up, moving limbs, not following commands, trying to climb out of bed"	**2**
"Compliance with the ventilator (intubated patient) or Vocalization (non-intubated patient)"	"Tolerating ventilator or movement"	"Alarms not activated, easy ventilation"	**0**
	"Coughing but	"Coughing, alarms may be activated"	**1**

	tolerating”		
	“Fighting ventilator”	“Asynchrony: blocking ventilation, alarms frequently activated”	**2**
“Vocalization”	“Talking in normal tone or no sounds”	“Talking in normal tone or no sound”	**0**
	“Sighing, moaning”	“Sighing, moaning”	**1**
	“Crying out, sobbing”	“Crying out, sobbing”	**2**
“Muscle tension Evaluation by passive flexion and extension of upper limbs (in rest or when patient is being turned)”	“Relaxed”	“No resistance to passive movement”	**0**
	“Tense, rigid”	“resistance to passive movements”	**1**
	“Very tense or rigid”	“Strong resistance to passive movements, inability to complete them”	**2**

Pre-procedure (2):

# of patient : **Name of the procedure: Suction**

Pain Assessment Variables

On analgesics infusion pump :

- Fentanyl
- Remifentanyl
- morphine
- None

On sedation infusion pump :

- Medazolam
- Propofol
- Dexmedetomidine
- None

Administrations any PRN analgesics:

- Fentanyl (IV)
- Hydromorphone (IV)
- Morphine (IV)
- Hydrocodone
- Acetaminophen
- None

Episodes of severe pain:

- Yes
- No

Vital Signs

BP	Mab	Pulse	RR	Temp

Behavioral Pain Scale (BPS)

Item	Description	Score
“Facial expression”	“Relaxed”	**1**
	“Partially tightened (e.g., brow lowering)”	**2**
	“Fully tightened (e.g.. eyelid closing)	**3**
	“Grimacing”	**4**
“Upper Limb movements”	“No movement”	**1**
	“Partially bent”	**2**
	“Fully bent with finger flexion”	**3**
	“Permanently retracted”	**4**
“Compliance with Coughing”	“Tolerating movement”	**1**
	“Coughing but tolerating ventilation for the most of time”	**2**
	“Fighting ventilator”	**3**
	“Unable to control ventilation”	**4**

BPS score ranges from 3 (no pain) to 12 (maximum pain)

Critical Care Pain Observation Tool

Indicator		Description	Score
"Facial expression"	"Relaxed, neutral"	"No muscle tension observed"	**0**
	"Tense"	"Presence of frowning, orbit tightening, levator contraction, or any other change (e.g., opening eyes or tearing during nociceptive procedures"	**1**
	"Grimacing"	"All previous facial movements plus eyelid tightly closed"	**2**
"Body movements"	"Absence of movements or normal position"	"Does not move at all or normal position (movements not aimed toward the pain site)"	**0**
	"Protection"	"Slow, cautious movements, touching, or rubbing the pain site, seeking attention through movements"	**1**
	"Restlessness"	"Pulling tube, attempting to sit up, moving limbs, not following commands, trying to climb out of bed"	**2**
"Compliance with the ventilator (intubated patient) or Vocalization (non-intubated patient)"	"Tolerating ventilator or movement"	"Alarms not activated, easy ventilation"	**0**
	"Coughing but	"Coughing, alarms may be activated"	**1**

	tolerating”		
	“Fighting ventilator”	“Asynchrony: blocking ventilation, alarms frequently activated”	**2**
“Vocalization”	“Talking in normal tone or no sounds”	“Talking in normal tone or no sound”	**0**
	“Sighing, moaning”	“Sighing, moaning”	**1**
	“Crying out, sobbing”	“Crying out, sobbing”	**2**
“Muscle tension Evaluation by passive flexion and extension of upper limbs (in rest or when patient is being turned)”	“Relaxed”	“No resistance to passive movement”	**0**
	“Tense, rigid”	“resistance to passive movements”	**1**
	“Very tense or rigid”	“Strong resistance to passive movements, inability to complete them”	**2**

Post-procedure (2):

# of patient : **Name of the procedure: Suction** **Pain Assessment Variables**
On analgesics infusion pump : ○ Fentanyl ○ Remifentanyl ○ morphine ○ None
On sedation infusion pump : ○ Medazolam ○ Propofol ○ Dexmedetomidine ○ None
Administrations any PRN analgesics: ○ Fentanyl (IV) ○ Hydromorphone (IV) ○ Morphine (IV) ○ Hydrocodone ○ Acetaminophen ○ None
Episodes of severe pain: ○ Yes ○ No

Vital Signs

BP	Mab	Pulse	RR	Temp

Behavioral Pain Scale (BPS)

Item	Description	Score
“Facial expression”	“Relaxed”	**1**
	“Partially tightened (e.g., brow lowering)”	**2**
	“Fully tightened (e.g.. eyelid closing)”	**3**
	“Grimacing”	**4**
“Upper Limb movements”	“No movement”	**1**
	“Partially bent”	**2**
	“Fully bent with finger flexion”	**3**
	“Permanently retracted”	**4**
“Compliance with Coughing”	“Tolerating movement”	**1**
	“Coughing but tolerating ventilation for the most of time”	**2**
	“Fighting ventilator”	**3**
	“Unable to control ventilation”	**4**

BPS score ranges from 3 (no pain) to 12 (maximum pain)

Critical Care Pain Observation Tool

Indicator		Description	Score
"Facial expression"	"Relaxed, neutral"	"No muscle tension observed"	**0**
	"Tense"	"Presence of frowning, orbit tightening, levator contraction, or any other change (e.g., opening eyes or tearing during nociceptive procedures"	**1**
	"Grimacing"	"All previous facial movements plus eyelid tightly closed"	**2**
"Body movements"	"Absence of movements or normal position"	"Does not move at all or normal position (movements not aimed toward the pain site)"	**0**
	"Protection"	"Slow, cautious movements, touching, or rubbing the pain site, seeking attention through movements"	**1**
	"Restlessness"	"Pulling tube, attempting to sit up, moving limbs, not following commands, trying to climb out of bed"	**2**
"Compliance with the ventilator (intubated patient) or Vocalization (non-intubated patient)"	"Tolerating ventilator or movement"	"Alarms not activated, easy ventilation"	**0**
	"Coughing but	"Coughing, alarms may be activated"	**1**

	tolerating”		
	“Fighting ventilator”	“Asynchrony: blocking ventilation, alarms frequently activated”	**2**
“Vocalization”	“Talking in normal tone or no sounds”	“Talking in normal tone or no sound”	**0**
	“Sighing, moaning”	“Sighing, moaning”	**1**
	“Crying out, sobbing	“Crying out, sobbing”	**2**
“Muscle tension Evaluation by passive flexion and extension of upper limbs (in rest or when patient is being turned)”	“Relaxed”	“No resistance to passive movement”	**0**
	“Tense, rigid”	“resistance to passive movements”	**1**
	“Very tense or rigid”	“Strong resistance to passive movements, inability to complete them”	**2**

Pre-procedure (3):

# of patient : **Name of the procedure: Change position** **Pain Assessment Variables**
On analgesics infusion pump : ○ Fentanyl ○ Remifentanyl ○ morphine ○ None
On sedation infusion pump : ○ Medazolam ○ Propofol ○ Dexmedetomidine ○ None
Administrations any PRN analgesics: ○ Fentanyl (IV) ○ Hydromorphone (IV) ○ Morphine (IV) ○ Hydrocodone ○ Acetaminophen ○ None
Episodes of severe pain: ○ Yes ○ No

Vital Signs

BP	Mab	Pulse	RR	Temp

Behavioral Pain Scale (BPS)

Item	Description	Score
Facial expression	Relaxed	**1**
	Partially tightened (e.g., brow lowering)	**2**
	Fully tightened (e.g.. eyelid closing)	**3**
	Grimacing	**4**
Upper Limb movements	No movement	**1**
	Partially bent	**2**
	Fully bent with finger flexion	**3**
	Permanently retracted	**4**
Compliance with Coughing	Tolerating movement	**1**
	Coughing but tolerating ventilation for the most of time	**2**
	Fighting ventilator	**3**
	Unable to control ventilation	**4**

BPS score ranges from 3 (no pain) to 12 (maximum pain)

Critical Care Pain Observation Tool

Indicator		**Description**	**Score**
Facial expression	Relaxed, neutral	No muscle tension observed	**0**
	Tense	Presence of frowning, orbit tightening, levator contraction, or any other change (e.g., opening eyes or tearing during nociceptive procedures	**1**
	Grimacing	All previous facial movements plus eyelid tightly closed	**2**
Body movements	Absence of movements or normal position	Does not move at all or normal position (movements not aimed toward the pain site)	**0**
	Protection	Slow, cautious movements, touching, or rubbing the pain site, seeking attention through movements	**1**
	Restlessness	Pulling tube, attempting to sit up, moving limbs, not following commands, trying to climb out of bed	**2**
Compliance with the ventilator (intubated patient)or Vocalization (non-intubated patient)	Tolerating ventilator or movement	Alarms not activated, easy ventilation	**0**
	Coughing but tolerating	Coughing, alarms may be activated	**1**

	Fighting ventilator	Asynchrony: blocking ventilation, alarms frequently activated	**2**
vocalization	Talking in normal tone or no sounds	Talking in normal tone or no sound	**0**
	Sighing, moaning	Sighing, moaning	**1**
	Crying out, sobbing	Crying out, sobbing	**2**
Muscle tension Evaluation by passive flexion and extension of upper limbs (in rest or when patient is being turned)	Relaxed	No resistance to passive movement	**0**
	Tense, rigid	resistance to passive movements	**1**
	Very tense or rigid	Strong resistance to passive movements, inability to complete them	**2**

Post-procedure (3):

# of patient: **Name of the procedure: Change position** **Pain Assessment Variables**
On analgesics infusion pump : ○ Fentanyl ○ Remifentanyl ○ morphine ○ None
On sedation infusion pump : ○ Medazolam ○ Propofol ○ Dexmedetomidine ○ None
Administrations any PRN analgesics: ○ Fentanyl (IV) ○ Hydromorphone (IV) ○ Morphine (IV) ○ Hydrocodone ○ Acetaminophen ○ None
Episodes of severe pain: ○ Yes ○ No

Vital Signs

BP	Mab	Pulse	RR	Temp

Behavioral Pain Scale (BPS)

Item	Description	Score
Facial expression	Relaxed	**1**
	Partially tightened (e.g., brow lowering)	**2**
	Fully tightened (e.g.. eyelid closing)	**3**
	Grimacing	**4**
Upper Limb movements	No movement	**1**
	Partially bent	**2**
	Fully bent with finger flexion	**3**
	Permanently retracted	**4**
Compliance with Coughing	Tolerating movement	**1**
	Coughing but tolerating ventilation for the most of time	**2**
	Fighting ventilator	**3**
	Unable to control ventilation	**4**

BPS score ranges from 3 (no pain) to 12 (maximum pain)

Critical Care Pain Observation Tool

Indicator		**Description**	**Score**
Facial expression	Relaxed, neutral	No muscle tension observed	**0**
	Tense	Presence of frowning, orbit tightening, levator contraction, or any other change (e.g., opening eyes or tearing during nociceptive procedures	**1**
	Grimacing	All previous facial movements plus eyelid tightly closed	**2**
Body movements	Absence of movements or normal position	Does not move at all or normal position (movements not aimed toward the pain site)	**0**
	Protection	Slow, cautious movements, touching, or rubbing the pain site, seeking attention through movements	**1**
	Restlessness	Pulling tube, attempting to sit up, moving limbs, not following commands, trying to climb out of bed	**2**
Compliance with the ventilator (intubated patient)or Vocalization (non-intubated patient)	Tolerating ventilator or movement	Alarms not activated, easy ventilation	**0**
	Coughing but tolerating	Coughing, alarms may be activated	**1**
	Fighting	Asynchrony: blocking ventilation, alarms	**2**

	ventilator	frequently activated	
vocalization	Talking in normal tone or no sounds	Talking in normal tone or no sound	**0**
	Sighing, moaning	Sighing, moaning	**1**
	Crying out, sobbing	Crying out, sobbing	**2**
Muscle tension Evaluation by passive flexion and extension of upper limbs (in rest or when patient is being turned)	Relaxed	No resistance to passive movement	**0**
	Tense, rigid	resistance to passive movements	**1**
	Very tense or rigid	Strong resistance to passive movements, inability to complete them	**2**

الجامعة العربية الأمريكية –جنين
كلية الدراسات العليا

مقارنة جودة القياس بين أداة مراقبة الألم في حالات الرعاية الحرجة ومقياس الألم السلوكي لتقييم الألم في المرضى البالغين الذين يخضعون للتهوية الميكانيكية: دراسة شبه تجريبية

إعداد

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تم تقديم هذه الرسالة استكمالاً لمتطلبات درجة الماجستير في تخصص طوارئ التمريض

2022

الملخص

الخلفية: كثيرًا ما يعاني المرضى المصابون بأمراض خطيرة من آلام إجرائية وألم أثناء الراحة. لقد ثبت أن إزالة أنبوب الصدر، وشفط القصبة الهوائية، والعناية بالجروح، واللف، وإدخال خط الشرايين هي الإجراءات الأكثر إيلامًا. تهدف هذه الدراسة إلى مقارنة القيمة التشخيصية لأداة مراقبة الألم في حالات الرعاية الحرجة (CPOT) ومقياس الألم السلوكي (BPS) لتقييم الألم بين المرضى غير الواعين.

المواد والطرق: تصميم دراسة وصفية، مستقبلية، مقطعية لمقارنة مقياس الألم السلوكي (BPS) وأداة مراقبة الألم في حالات الرعاية الحرجة (CPOT) في الكشف عن آلام المريض قبل وبعد الإجراءات الجراحية لوحدة العناية المركزة ومقارنة شدة الألم في الإجراءات الغازية في مستشفى جنين ومستشفى رفيديا. تم قبول ثلاثين مريضاً في وحدة العناية المركزة في مستشفيات رفيديا الحكومية وجنين في شمال الضفة الغربية خلال ثلاثة أشهر.

النتائج: تم إجراء اختبار الارتباط بين كل من BPS وCPOT بعد إجراءات الألم. أظهر التحليل أن BBS وCPOT مرتبطان ارتباطًا وثيقًا في القنية المطبقة وشفط الإفراز وتغيير الموضع وإجراءات عصا الإبرة (0.838 و0.838 و0.987 و0.968) على التوالي عند p <0.001.

الخلاصة: أوضحت الدراسة أن كلا المقياسين مناسبان لتقييم الألم في المرضى الذين يتم إدخالهم بالتنبيب الفموي الرغامي إلى وحدات العناية المركزة.

كلمات مفتاحية: ألم؛ مرض خطير، عناية حرجة؛ مقياس الألم السلوكي، أداة مراقبة آلام العناية

الحرجة، قياس الألم.