Effect of Supine versus Right Lateral Position on Intra-Abdominal Pressure Measurements and Respiratory Dynamics for Critically Ill Patients

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Abstract

Background: Intra-abdominal pressure measurement (IAP) is a critical hemodynamic assessment used in the intensive care unit (ICU) to identify patients at risk for intra-abdominal hypertension and subsequent abdominal compartment syndrome. **Aim:** Assess the effect of supine versus right lateral position on intra-abdominal pressure measurements and respiratory dynamics for critically ill patients. **Design & Setting:** Quasi-experimental research design was carried out in the Surgical Intensive Care Unit of Emergency Tanta University Hospitals which is affiliated to the Ministry of Higher Education and Scientific Research. **Subjects**: A purposive sample of sixty critically ill patients ranging in age from 21 to 60 years. **Tools:** Three tools were utilized **Tool (I): Critically Ill Patients Assessment Tool:** It included 3 parts as the following: **Part (a):** Patients' Demographic Characteristics, **Part (b):** Patients' Clinical Data**,** and **Part (c):** Patients' Hemodynamic Parameters, **Tool (II):** Intra-abdominal Pressure Measurements Recording Sheet, and **Tool (III):** Respiratory Dynamics Assessment Sheet. **Results:** No a statistically significant difference regarding Intra-abdominal pressure measurements when the head of the bed (HOB) angle had been changed from 0° to 15° in supine position and right lateral position where $P > 0.05$. Moreover, lung compliance negatively correlated with IAP with highly statistically significant differences where $P<0.01$. Meanwhile, airway resistance, respiratory rate & BMI positively correlated with IAP with highly statistically significant differences where $P= 0.000$. **Conclusions:** There were no significant differences between IAP measurements in the supine position versus right lateral position. **Recommendations:** It can be recommended that further studies are needed to evaluate the various methods of IAP measurements, and the study should be replicated on large probability sample on different setting to generalize results.

Keywords: Critically ill patients, intra-abdominal pressure measurements, respiratory dynamics, right lateral position and supine position.

Introduction

Critically ill patients are those with life-threatening organ dysfunction or at high risk of deterioration and poor outcome either in terms of mortality or morbidity with prolonged hospital stay, which has a great impact on medical cost. In addition, critically ill patients struggle between life and death and may tend to lose their lives anytime. Therefore, they need remarkable observation **(El Khattab Amin, Fawaz, Hana & Elkolfat, 2024; Pais, Rao, Muniyal & Yun, 2024).**

The global incidence of adult critical illness is estimated to be between 30 and 45 million annually, based on the estimation of particular diagnoses from a North American ICU registry to the worldwide population **(Schell et al., 2023).** Moreover, epidemiological studies indicate that up to 70% of patients admitted to the intensive care unit (ICU) ultimately necessitate mechanical ventilation **(Abate et al., 2023).**

In Egypt, the incidence of patients who are required mechanical ventilation in ICUs represents about 40–65%. Patients on mechanical ventilation at the Surgical ICU at Tanta University Hospitals in Gharbia, Egypt, are about 55% of total cases **(Younis et al., 2023).**

Critically ill patients experience rapid changes in their condition during their stay in the ICU. As a result, many indicators change dramatically **(Wang et al., 2024).** In this regard, **Urden et al. (2021)** pointed out that measurement of hemodynamic parameters is considered the most crucial duty of nurses who work in the ICU. Moreover, monitoring and evaluating intra-abdominal pressure (IAP), same as the other hemodynamic indicators, constitutes the responsibilities of ICU nurses. **(Samimian, Khaleghdoost, Ashraf & Hakimi, 2021).**

Intra-abdominal pressure (IAP) is a critical physiological indicator that indicates the persistent pressure within the cavity of the abdomen, arising from the connection between the abdominal wall and the internal organs (**Tayebi, Wise, Pourkazemi, Stiens & Malbrain, 2022**). Furthermore, variances in intra-abdominal pressure are based upon the respiratory cycle and the resistance of the abdominal wall. In healthy individuals, IAP typically measures below 7 mmHg. Nonetheless, critically ill patients typically exhibit a baseline IAP of around 10 mmHg **(Staelens et al., 2023).** IAP of 12 mmHg or over is classified as intra-abdominal hypertension **(Chen et al., 2023).**

Intra-abdominal pressure may be affected by various factors, including body mass index, abdominal wall movement, the size of intra-abdominal organs, position and respiration. Given that the peritoneal cavity is a sealed space, alterations in any of these factors will elevate the IAP **(Liao et al., 2021; Silva et al., 2021).**

Positioning is a prevalent and essential nursing task conducted in ICU. It often acts as a central element that directs other nursing tasks **(Ismail, Mohammad & Mourad, 2021).** A multicenter analysis revealed considerable variations in

IAP measurements across different head of bed positions. The placement of the transducer at the mid axillary line or at the level of the symphysis pubis may introduce bias **(Depauw et al., 2019).** Moreover, the supine posture (laying on the back) can create challenges for individuals with abdominal pressure (AP), as it can exacerbate abdominal discomfort and respiratory distress **(Li et al., 2023).**

Furthermore, substantial respiratory and circulatory alterations occur when body posture changes **(Elzohry, Abd El Khalik & Ismael Roushdy, 2020).** In a supine position, the diaphragm must contract against the pressure produced by abdomen and intra-abdominal organs to shift and compress lung tissue, resulting in reduced functional residual capacity, reduced heart rate, and diminished peripheral vascular resistance. Also interfere with the native protective mechanism (e.g., cough, mucociliary clearance) and facilitate pulmonary aspiration. Thus, it can contribute to the pathogenesis of ventilator-associated pneumonia **(Arora, Patil, Saif &Khude, 2024; Güner & Kutlutürkan, 2022).**

The lateral position improves ventilation and enhances oxygen saturation. Furthermore, maintaining a lateral position also seeks to avoid spinal compression, so enhancing respiration and reducing pressure on bodily organs. The suggested position is the right lateral position (laying on the side). The oxygen saturation level during sleep is greater in the right lateral position compared to the left in cardiopulmonary patients **(Agustina, Nurhaeni & Hayati, 2021).**

Moreover, the right lateral position may effectively decrease residual gastric volume, reduce regurgitation and aspiration in adults, and decrease the incidence of ventilator-associated pneumonia **(Farsi, Butler & Zareiyan, 2020; Pozuelo-Carrascosa et al., 2022).** The present study aims to assess the effect of supine versus right lateral position on intra-abdominal pressure measurements and respiratory dynamics in critically ill patients.

Significance of the study

Evaluating intra-abdominal pressure (IAP) in critically ill ICU patients protects these patients from developing serious complications that will result from a pathological increase of IAP from abdominal surgery, major trauma, acute pancreatitis, massive fluid resuscitation or positive fluid balance, and mechanical ventilation **(Silva, Ball, Rocco & Pelosi, 2022).** Consequently, it should consider IAP as the 6th vital sign, alongside heart rate, respiration rate, blood pressure, core body temperature, and peripheral oxygen saturation **(Tayebi et al., 2023).**

The researcher noticed in real-time practice that most critically ill intubated patients did not undergo monitoring of IAP by ICU nurses. It was observed that several ICU nurses lacked understanding regarding significance of IAP measurement. The conditions may result from ICU staff repositioning patients, although they did not assess IAP. However, a few nurses monitor the patient's hemodynamic status following the administration of nursing care. There is little proof about the impact of right-side posture on IAP. Therefore, this study aims to assess effect of supine versus right lateral position on intra-abdominal pressure measurements and respiratory dynamics for critically ill patients.

Aim of the study

The aim of this current study was to assess the effect of supine versus right lateral position on intra-abdominal pressure measurements and respiratory dynamics for critically ill patients.

Research hypotheses

1. Critically ill patients who are placed at right lateral position are expected to have less alteration of IAP measurements than at supine position .
2. Critically ill patients who are placed at right lateral position are expected to have an improvement in respiratory dynamics than at supine position.

Subjects and method

Subjects

Research design:

A quasi- experimental research design was utilized in this study.

Setting:

The study was conducted in the Surgical ICU of Emergency Tanta University Hospitals, Gharbia Governorate which affiliated to Ministry of Higher Education and Scientific Research. This unit consists of four rooms, each with four beds, resulting in a total of sixteen beds.

Subjects:

A purposive sample of sixty adult critically ill patients who met the inclusion criteria was obtained from the mentioned setting. The sample size was determined utilizing the Epi Info 7 Statistical Program, and the total number of individuals admitted annually, as per the analysis of Tanta University Hospital's statistical health records for 2023, was 150 patients and the sample size calculated as the following:

- Total patients are 150 annually
- Confidence level= 99.9%
- Expected frequency= 50%
- Accepted error= 5%
- Confidence coefficient= 95%

The subjects were selected according to the following inclusion criteria:

- Adult patients are twenty-one years and older.
- Both sexes.
- Patients on Synchronized Intermittent Mandatory Ventilation (SIMV) mode with positive end expiratory pressure (PEEP) equal 5 cm H2O.
- Having indwelling urinary catheter.

Exclusion criteria:

- Patients with pulmonary edema.
- Pregnant women.
- Patients with neurogenic bladder, bladder rupture and hematuria.
- Patients with pelvic fracture.

Tools of data collection: -

To collect the necessary data, 3 tools were utilized in this study as the following:

Tool I: Critically Ill Patients Assessment Tool: -

This tool was developed by the researcher after reviewing related literature **(Allam, et al.,2023; Hsu, et**

al., 2024; Hak et al., 2022; Khalil et al., 2021; Lauridsen et al., 2022; Ramazani & Hosseini., 2022; and Shehab., 2017) to evaluate demographic, clinical data of the critically ill cases and urinary indwelling catheter. It includes 3 parts as the following:

Part (a): Patients' Demographic Characteristics:

Which was included demographic characteristics of patients such as; patient's code, age, gender, marital status and education level.

Part (b): Patients' Clinical Data:

It was used to assess clinical data as current medical diagnosis, past medial history, body mass index, type of urinary catheter, size and number of urinary catheter lumens.

Part (c): Patients' Hemodynamic Parameters:

It was used to assess systolic blood pressure, diastolic blood pressure, mean arterial pressure, respiratory rate, pulse rate and temperature.

Tool II: Intra-abdominal Pressure Measurements Recording Sheet:

The tool was created by the researcher following a relevant literature review **(Rajasurya & Surani., 2020)** to detect changes of intra-abdominal pressure at different position and then grading intra-abdominal pressure that was estimated by mean and standard deviation into the following grades.

Scoring system:-

Grading of IAP	IAP (mmHg)
Normal **IAP**	>12
IAH Gade **I**	12-15
IAH Gade **II**	16-20
IAH Gade **III**	21-25
IAH Gade **IV**	>25

Tool III: Respiratory Dynamics Assessment Tool

This tool was created by the researcher after reviewing related literature **(Kulkarni & Sheela., 2020)** and it included an assessment of the following: -

- **Airway Resistance** is the opposition or obstruction to airflow during respiration. Calculated by equation: **R= (Pmax- Pplat)/Vi.** While R represents airway resistance, Pmax represents maximum airway pressure, Pplat represents plateau pressure, vi represents flow rate of gas during inspiration.
- **Lung compliance** is the measure of stretchability or elasticity of the lungs. calculated by equation: **Clt = vt/ (Pplat - PEEP).** While Clt represents lung compliance, vt represents tidal volume, Pplat represents plateau pressure, PEEP represents positive end expiratory pressure**.**

Methods

1. **An official permission** was obtained from the Dean of the Faculty of Nursing at Tanta University and directed to the director of the Surgical Intensive Care Unit at Tanta Emergency Hospital inside Tanta University Hospitals, to obtain approval for collecting necessary study data from the chosen setting.
2. **Ethical considerations:**

- Approval of the Ethical Committee of the Faculty of Nursing Tanta University was obtained **(420-3-2024).**
- Consent was obtained from the first-degree family member of patients on mechanical ventilation before participation of their patients in this study and posts

clarification the aim of the current study.

- Family members of the studied patient were informed that each participant had the opportunity to withdraw from the study at any point during the study procedure without incurring any penalties.
- The study did not inflict any harm on the intubated individuals.
- Confidentiality was preserved through the utilization of a code number instead of a name.

3. **Tool development:** The researcher constructed the study methods based on a review of pertinent literature.
4. **Tools validity** was tested for content validity by five experts in the field of specialty such as Critical Care and Emergency Nursing, and Biostatistics.
5. **Reliability**: Tools were evaluated for reliability and alpha Cronbach's alpha was calculated for standardized items, yielding values of 0.896, 0.848, and 0.900 for tools **I**, **II**, **III** respectively, indicating high reliability.
6. **A pilot study** was conducted by the researcher on 10% of the subjects to evaluate the tools for clarity, applicability, and to determine potential impediments that may arise during gathering data. Consequently, the researcher reworded and incorporated supplementary terminology before the primary research study. The pilot study was excluded from the total number of study sample.
7. **Data Collection:**

- Data was collected during a six-month period, commencing at the beginning of June 2024 and until the end of December 2024.
- **The study was carried out in four phases as follows:**

A. Assessment phase: -

- The researcher conducted a primary assessment for all mechanically ventilated patients at the previously mentioned setting to ascertain which patient fulfilled the study's inclusion criteria.
- Evaluation of Patients' demographic data, clinical, urinary catheter and hemodynamic parameters were carried out utilizing the developed tool **I** part (A, B and C).
- Intra-abdominal pressure and respiratory dynamics parameters were measured two times per day in the morning and evening shift at two different positions with 15 minutes interval for each within 48 hours by researcher using the developed tool **II & III**.

B. Planning phase: -

This phase was designed based on the assessment phase and a review of the literature. Priorities and expected outcome criteria were considered in the design of patient treatment.

Expected clinical outcomes include:

The patients at right lateral position maintain intra-abdominal pressure measurements with less alteration and exhibit an improvement of respiratory dynamics.

C. Implementation phase:

This phase included the following;

The IAP measurement was done

through urinary bladder using manometer, extension tube, clamp, Ryle syringe 50 ml and 0.9% NaCl fluid. Measurements were made with the following steps: -

1. **Preparation**

Under sterile conditions, the researcher connected the extension tube to Foley catheter patients as following:

- The Ryle syringe filled with liquid NaCl 0.9% at 50 ml.
- The manometer connected to extension tube.
- The catheter clamped at the distal part beyond the sample port with a non-crushing clamp.
- Disconnect the catheter from the drainage tubing
- Ensured that urine in the Foley catheter was completely released.
- The researcher instilled 50 ml of sterilized normal saline solution with body temperature gently into the bladder, applying non-crushing clamp.
- Connect extension tube with manometer to the open end of the catheter.

2. **Intra-abdominal measurement technique at supine and right lateral position:**

- Establish the zero point by drawing a parallel line from the symphysis pubis laterally, and then extend the axillary line medially at the iliac crest region along the mid-auxiliary line.
- The zero point of water monument adjusted with the marked area.
- After instilling saline, must wait 30-60 seconds to give bladder muscle time to relax and to create a balance between a patient's body after injecting normal saline solution and adjusting the patients at a head-of-bed angle.
- The patient put in supine position with head of the bed at (0) degree angle and after 5 minutes the patient put at (15) degree angle.
- Then the patient put in right lateral position with head of the bed at a (0) angle and after 5 minutes the patient put at (15) degree angle.
- The researcher Placed hand over abdomen to assess for muscle relaxation.
- The researcher removed the clamp from the Foley probe after 30 seconds to open between the water monometer and the patient then the IAP recorded at end-expiratory after some respirations.
- After measurement of IAP the extension tube disconnected from the catheter and reconnected the drainage bag.
- Each IAP value was obtained by manometer (cmH2O) and recalculated in millimeter mercury using the conversion factor (1 cmH2O = 0.74 mmHg).

D. Evaluation phase:

Evaluation of intra-abdominal pressure and respiratory dynamics in supine and right lateral position at 0 and15 degree angle for each position with 15 minutes interval for each by using tool **II** and **III**. This will be performed 2 times with 6 hours interval during morning and afternoon shift within 48 hours.

Results:

Table (1) shows distribution of socio-demographic characteristics among the critically ill patients studied. It was observed that, more than one third (36.67%) of studied patients aged between 50 to 60 years old with the Mean ± SD 42.70±12.78, more than half (53.33% & 58.33%) of them were males and married respectively. Also, this result showed that more than one third (40.00%) of the subjects had secondary education.

Table (2) represents distribution of the studied critically ill patients regarding their clinical data.

Regarding current medical diagnosis, it was showed that, more than one third of patients (38.33%) were diagnosed with post-operative disorder and less than one third (30.00%) of them had poly trauma. **Concerning comorbidities and past medical history,** the current study found that less than half of studied sample (45.00%) had past history for cardiovascular disorders.

In regarding to BMI, it was found that more than one third of studied subjects (41.67%) were overweight, with the Mean ± SD 26.55±4.01. While, related the urinary catheter assessment, the result showed that all the patients (100%) had transurethral urinary catheter with double lumen. Additionally, it was found that less than half (48.33% &45.00%) of the patients were catheterized with 18 Fr or 16 Fr catheter size respectively.

Table (3) Mean scores of hemodynamic parameters among the studied critically ill patients at 1st and 2nd days of implementation.

Concerning blood pressure, the result illustrates that A statistically significant difference was observed in systolic blood pressure among the studied patients while in the supine posture at the head of bed (0&15) degree on the 2nd day as p value = (0.042). Moreover, there was a statistically significant difference among the subjects regarding SBP, DBP& MAP in the supine versus right lateral position at the head of bed (0&15) degree in the 2nd day only as p value = (0.031, 0.019, 0.034, 0.022, 0.028 & 0.023) respectively.

Regarding respiratory rate, A significant statistical difference was seen among the studied subjects in the supine and right lateral positions at the head of bed (0&15) degree in the 1st day at p value = (0.007 &0.015) respectively and also in the 2nd day at p value (0.018&0.017) respectively. Moreover, there was a highly statistically significant difference among the studied patients in the supine versus right lateral position at the head of bed (0&15) degree on the 1st day at p value = (0.000 & 0.000) respectively and also in the 2nd day at p value (0.000&0.000) respectively.

Table (4) represents mean scores of IAP measurements with different body position among the studied critically ill patients at 1st and 2nd days of implementation.

Regarding IAP reading at supine position, it was found that the mean IAP at the morning at the head of bed at (0) angle was (10.12±3.57) in the 1st day compared to (10.08±3.81) in the2nd day respectively. Also, it was found that the mean IAP at the evening at Head of bed at (0) angle was (10.32±3.69) in the 1st day compared to (10.08±3.82) in the2nd day respectively.

Further, it was found that the mean IAP at the morning at Head of bed at (15) angle was (11.12±3.57) in the 1st day compared to (11.08±3.81) in the2nd day respectively. Also, it was found that the mean IAP at the evening at Head of bed at (15) angle was (11.32±3.69) in the 1st day compared to (11.03±3.85) in the 2nd day respectively.

Concerning IAP reading at right lateral position, it was found that the mean IAP at the morning at Head of bed at (0) angle was (11.40±3.71) in the 1st day compared to (11.38±3.94) in the2nd day respectively. Also, it was found that the mean IAP at the evening at Head of bed at (0) angle was (11.55±3.79) in the 1st day compared to (11.37±3.99) in the 2nd day respectively.

Further, it was found that the mean IAP at the morning at Head of bed at (15) angle was (12.40±3.68) in the 1st day compared to (12.40±3.89) in the 2nd day respectively. Also, it was found that the mean IAP at the evening at Head of bed at (15) angle was (12.32±4.07) in the 1st day compared to (12.33±3.96) in the 2nd day respectively.

In addition, this table illustrates that there were no significant differences between IAP measurements in supine position versus right lateral position throughout all period of the study in which P>0.05.

Table (5) reveals mean scores of respiratory dynamics measurements of supine versus right lateral position among the critically ill patients studied at 1st and 2nd days of implementation.

Regarding lung compliance, A significant statistical difference was seen between the critically ill patients studied in the supine and right lateral positions at the head of the bed (0° and 15°) on the first day at p value (0.010&0.015) respectively and also in the 2nd day as p value (0.009&0.026) respectively. Moreover, there was a statistically significant difference among the studied patients in the supine versus right lateral position at the head of bed (15) degree on the 1st and the 2nd day where p value (0.045&0.037) respectively.

Related to airway resistance, it was found that there was not a statistically significant difference between the subjects in the supine and right lateral position at the head of the bed (0&15) degree in the 1st day and the 2nd day of implementation as p value (>0,05).While, there was a statistically significant difference among the studied patients in the supine versus right lateral position at the head of bed (0&15) degree in the 1st day at p value (0.019&0.001) respectively and also in the 2nd day as p value (0.004&0.003) respectively.

Table (6&7) shows correlation between clinical data of the critically ill patients studied and intra-abdominal pressure measurements at 1st & 2nd day of implementation.

This table illustrates that the highest mean score of IAP measurements in supine and right lateral position at head of bed at (0&15) angle at 1st &

2nd day of implementation in cases with acute respiratory distress syndrome. While, the highest mean score of IAP measurements at supine and right lateral position at head of bed at (0&15) degree was seen with the obese patients in the 1st & 2nd day of implementation. Also, the highest mean score of IAP measurements at supine and right lateral position at head of bed at (0&15) degree was seen in the patients with urinary catheter with 18 fr in the 1st & 2nd day of implementation.

Moreover, this table shows a highly statistically difference was found in the mean score of IAP& body mass index in the 1st & 2nd day respectively where P value = 0.000.

Table (8) represents correlation between intra-abdominal pressure measurements and respiratory dynamics of the studied critically ill patients.

This table shows that there was a highly statistically significant negative correlation observed among the studied critically ill patients in the supine and right lateral position at degree (0&15) regarding IAP measurements and CLt throughout all the period of the study in which P<0.01. While, a highly statistically significant positive correlation was observed among the studied patients in **the supine** at degree (0&15) regarding IAP measurements and Raw throughout all the period of the study in which P= 0.000. Also, a highly statistically significant positive correlation was observed among the studied critically ill patients in the **right lateral** position at degree (0&15) regarding IAP measurements and Raw in the 2nd day of implementation in which P= 0.000.

Table (9) illustrates correlation between hemodynamics and intra-abdominal pressure measurements of the studied critically ill patients.

This table illustrates that there was a statistically significant negative correlation among the critically ill patients studied regarding IAP measurements and DBP in the supine and right lateral position at degree (0&15) in the 2nd day of the study as P value = (0.026, 0.027, 0.015, 0.012, 0.032, 0.033& 0.014) respectively. Also, a statistically significant negative correlation was observed among the studied critically ill patients in the supine at (15) degree regarding IAP measurements and MAP at the morning and evening of the 2nd day as P value = (0.042, 0.035) respectively.

In addition, it was found that there was a high statistically significant positive correlation between IAP & RR at the supine and right lateral position at degree (0&15) in the morning and evening of the 2nd day with as P value = (0.008, 0.013, 0.004, 0.005, 0.003,0.003,0.005&0.002) respectively.

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

Characteristics	The studied patients (n=60)	
	N	%
Age (in years)		
▪ (21-<30)	14	23.33
▪ (30-<40)	15	25.00
▪ (40-<50)	9	15.00
▪ (50-60)	22	36.67
Range Mean ± SD	(21-59) 42.70±12.78	
Gender		
▪ Male	32	53.33
▪ Female	28	46.67
Marital status		
▪ Married	35	58.33
▪ Single	12	20.00
▪ Divorced	4	6.67
▪ Widow	9	15.00
Level of education		
▪ Illiterate	10	16.67
▪ Read and write	6	10.00
▪ Primary education	6	10.00
▪ Secondary education	24	40.00
▪ University educated	14	23.33

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

Clinical data	The studied patients (n=60)	
	N	%
Current medical diagnosis		
▪ Acute respiratory distress syndrome	2	3.33
▪ Poly trauma	18	30.00
▪ Acute respiratory failure	8	13.33
▪ Post-operative disorder	23	38.34
▪ Cerebrovascular accident	9	15.00
# Past medial history		
▪ None	12	20.00
▪ Cardiovascular disorders	27	45.00
▪ Respiratory disease	12	20.00
▪ Hepatic disorders	3	5.00
▪ Neurological disorders	4	6.67
▪ Endocrine disorders	22	36.67
Weight (in Kg) Range Mean ± SD	(51-108) 76.85±11.82	
Height (in Cm) Range Mean ± SD	(157-186) 170.25±8.39	
Body mass index		
▪ Normal (18.5–24.9)	24	40.00
▪ Overweight (25–<30)	25	41.67
▪ Obese (≥30)	11	18.33
Range Mean ± SD	(19.36-37.37) 26.55±4.01	
Urinary catheter assessment		
Types		
▪ Transurethral	60	100.00
Size		
▪ 16 fr	27	45.00
▪ 18 fr	29	48.33
▪ 20 fr	4	6.67
Number of catheter lumens		
▪ Double lumen	60	100.00

More than one answer was chosen

Table (3): Mean scores of hemodynamic parameters among the studied critically ill patients at 1st and 2nd days of implementation

Parameters	The studied patients (n=60) Range Mean ± SD											
	1st day						2nd day					
	Supine position		t P	Right lateral position		t P	Supine position		t P	Right lateral position		t P
	0-angle	15-angle		0-angle	15-angle		0-angle	15-angle		0-angle	15-angle	
1. Blood pressure												
▪ Systolic (SBP)	(95-147) 119.33±11.73	(96-150) 122.85±12.36	1.60 0.113	(93-143) 116.07±11.20	(94-146) 118.88±11.56	1.36 0.178	(91-139) 122.08±9.18	(92-140) 125.67±9.85	2.06 0.042*	(90-137) 118.57±8. 47	(91-138) 121.53±9.09	1.85 0.067
Supine Vs Right lateral t , P	1.56 , 0.121	1.82 , 0.072					2.18 , 0.031*	2.39 , 0.019*				
▪ Diastolic (DBP)	(60-90) 72.47±7.24	(60-90) 74.68±7.70	1.62 0.107	(59-89) 70.95±6.66	(60-90) 72.07±7.04	0.89 0.374	(60-88) 74.35±6.70	(60-88) 76.22±7.29	1.46 0.147	(60-87) 71.92±5.67	(60-88) 73.38±5.98	1.38 0.171
Supine Vs Right lateral t , P	1.20 , 0.235	1.94 , 0.054					2.15 , 0.034*	2.33 , 0.022*				
2. Mean arterial pressure (MAP)	(72-108) 87.65±8.26	(73-110) 90.28±8.63	1.71 0.090	(71-106) 85.72±7.69	(71-107) 87.33±8.18	1.11 0.268	(70-105) 89.87±7.13	(70-105) 92.32±7.80	1.80 0.075	(70-103) 87.18±6.05	(70-104) 89.28±6.58	1.82 0.071
Supine Vs Right lateral t , P	1.32 , 0.188	1.92 , 0.057					2.22 , 0.028*	2.30 , 0.023*				
3. Heart rate (HR)	(74-117) 92.73±10.56	(71-116) 90.25±10.87	1.27 0.207	(70-115) 89.22±10.77	(68-114) 87.03±11.11	1.09 0.277	(74-123) 89.32±11.16	(70-121) 86.58±11.76	1.31 0.194	(71-120) 85.58±11.62	(68-119) 83.40±11.95	1.02 0.312
Supine Vs Right lateral t , P	1.81 , 0.074	1.60 , 0.112					1.80 , 0.075	1.47 , 0.144				
4. Temperature (° c)	(36.6-38) 37.29±0.37	(36.6-38) 37.29±0.35	0.08 0.939	(36.6-37.8) 37.26±0.29	(36.6-37.9) 37.27±0.30	0.16 0.876	(36.5-37.7) 37.23±0.24	(36.5-37.7) 37.25±0.23	0.35 0.728	(36.6-37.7) 37.25±0.20	(36.6-37.8) 37.26±0.21	0.35 0.725
Supine Vs Right lateral t , P	0.50 , 0.618	0.28 , 0.779					0.41 , 0.684	0.37 , 0.710				
5. Respiratory rate (RR)	(17-27) 21.42±2.37	(16-25) 20.27±2.26	2.72 0.007*	(16-24) 19.37±2.16	(16-23) 18.43±2.00	2.46 0.015*	(18-29) 20.77±2.68	(17-27) 19.60±2.67	2.39 0.018*	(16-26) 18.77±2.53	(15-25) 17.67±2.45	2.42 0.017*
Supine Vs Right lateral t , P	4.96 , 0.000*	4.71 , 0.000*					4.20 , 0.000*	4.13 , 0.000*				

* Statistically significant at level P<0.05

Table (4): Mean scores of intra-abdominal pressure measurements with different body position among the studied critically ill patients at 1st and 2nd days of implementation

Intra-abdominal Pressure Measurements	The studied patients (n=60) Range Mean ± SD											
	1st day						2nd day					
	Supine position		t P	Right lateral position		t P	Supine position		t P	Right lateral position		t P
	0-angle	15-angle		0-angle	15-angle		0-angle	15-angle		0-angle	15-angle	
1. Morning	(4-21) 10.12±3.57	(5-22) 11.12±3.57	1.536 0.127	(5-23) 11.40±3.71	(6-24) 12.40±3.68	1.918 0.058	(5-23) 10.08±3.81	(6-24) 11.08±3.81	1.441 0.152	(6-24) 11.38±3.94	(7-25) 12.40±3.89	1.422 0.158
Supine Vs Right lateral t P	1.93 0.056	1.88 0.063					1.84 0.068	1.88 0.063				
2. Evening	(4-23) 10.32±3.69	(5-24) 11.32±3.69	1.483 0.141	(5-25) 11.55±3.79	(6-26) 12.32±4.07	1.066 0.288	(5-22) 10.08±3.82	(6-23) 11.03±3.85	1.358 0.177	(6-23) 11.37±3.99	(7-24) 12.33±3.96	1.333 0.185
Supine Vs Right lateral t P	1.83 0.074	1.41 0.162					1.81 0.074	1.82 0.071				

Table (5): Mean scores of respiratory dynamics measurements of supine versus right lateral position among the studied critically ill patients at 1st and 2nd days of implementation

Respiratory dynamics assessment	The studied patients (n=60) Range Mean ± SD											
	1st day						2nd day					
	Supine position		t P	Right lateral position		T P	Supine position		t P	Right lateral position		t P
	0-angle	15-angle		0-angle	15-angle		0-angle	15-angle		0-angle	15-angle	
1.Lung compliance (Clt)	(30-88) 55.40±14.61	(20-96) 62.53±15.43	**2.61 0.010***	(26-83) 50.38±14.49	(32-91) 56.95±14.74	**2.46 0.015***	(25-92) 56.33±15.56	(32-101) 63.88±15.81	**2.64 0.009***	(21-87) 51.35±15.52	(26-96) 57.80±15.82	**2.25 0.026***
Supine Vs Right lateral t , P	1.89 , 0.061	**2.03 , 0.045***					1.76 , 0.082	**2.11 , 0.037***				
2.Airway Resistance (Raw)	(5.3-12.6) 9.17±1.67	(4.8-12.1) 8.58±1.62	1.93 0.056	(6.3-15.3) 10.94±2.56	(5.8-12.8) 9.64±1.61	1.75 0.083	(5.3-13.7) 9.02±1.97	(4.8-12.7) 8.44±1.91	1.62 0.108	(6.3-15.2) 10.09±2.03	(5.8-14.2) 9.51±1.97	1.61 0.110
Supine Vs Right lateral t , P	**2.37 , 0.019***	**3.56 , 0.001***					**2.96 , 0.004***	**3.02 , 0.003***				

* Statistically significant at level P<0.05

Table (6): Correlation between clinical data of the studied critically ill patients and intra-abdominal pressure measurements at 1^{st} day of implementation

Clinical data	The studied patients (n=60) Intra-abdominal pressure measurements Mean ± SD 1^{st} day							
	Supine position				Right lateral position			
	0-angle		15-angle		0-angle		15-angle	
	Morning	Evening	Morning	Evening	Morning	Evening	Morning	Evening
Current medical diagnosis								
▪ Acute respiratory distress syndrome	12.00±5.66	12.00±7.07	13.00±5.66	13.00±7.07	13.50±6.36	13.50±7.78	**14.50±6.36**	**14.50±7.78**
▪ Poly trauma	8.28±2.68	8.67±2.68	9.28±2.68	9.67±2.68	9.56±2.81	9.94±2.78	10.56±2.81	10.94±2.78
▪ Acute respiratory failure	10.38±2.88	10.63±3.25	11.38±2.88	11.63±3.25	11.38±2.88	11.63±3.25	12.38±2.88	12.63±3.25
▪ Post-operative disorder	10.52±2.81	10.57±2.69	11.52±2.81	11.57±2.69	11.83±2.73	11.83±2.64	12.87±2.74	12.87±2.63
▪ Cerebrovascular accident	**12.11±5.67**	**12.33±6.19**	**13.11±5.67**	**13.33±6.19**	**13.56±6.13**	**13.56±6.52**	14.44±6.00	14.44±6.41
F , P	2.31 0.069	1.81 0.141	2.31 0.069	1. 81 0.141	2.29 0.071	1.67 0.171	2.26 0.074	1.64 0.179
Body mass index								
▪ Normal	7.96±2.35	8.33±2.39	8.96±2.35	9.33±2.39	9.21±2.30	9.58±2.36	10.21±2.30	10.58±2.36
▪ Overweight	10.00±2.42	9.88±2.56	11.00±2.42	10.88±2.56	11.24±2.60	11.04±2.67	12.28±2.62	12.08±2.68
▪ Obese	**15.09±3.15**	**15.64±3.26**	**16.09±3.15**	**16.64±3.26**	**16.55±3.48**	**17.00±3.55**	**17.45±3.39**	**17.91±3.48**
F , P	**29.94 0.000***	**29.65 0.000***	**29.94 0.000***	**29.65 0.000***	**28.63 0.000***	**28.59 0.000***	**28.14 0.000***	**28.07 0.000***
Size of urinary catheter								
▪ 16 fr	10.15±3.79	10.33±4.05	11.15±3.79	11.33±4.05	11.48±3.95	11.56±4.12	12.48±3.95	12.56±4.12
▪ 18 fr	**10.41±3.45**	**10.59±3.53**	**11.41±3.45**	**11.59±3.53**	**11.69±3.58**	**11.86±3.66**	**12.69±3.51**	**12.86±3.58**
▪ 20 fr	7.75±2.50	8.25±1.89	8.75±2.50	9.25±1.89	8.75±2.50	9.25±1.89	9.75±2.50	10.25±1.89
F , P	0.98 0.381	0.70 0.503	0.98 0.381	0.70 0.503	1.12 0.334	0.83 0.443	1.14 0.327	0.84 0.436

* Statistically significant at level P<0.0

Table (7): Correlation between clinical data of the studied critically ill patients and intra-abdominal pressure measurements at 2nd day of implementation

Clinical data	The studied patients (n=60) Intra-abdominal pressure measurements Mean ± SD							
	2nd day							
	Supine position				Right lateral position			
	0-angle		15-angle		0-angle		15-angle	
	Morning	Evening	Morning	Evening	Morning	Evening	Morning	Evening
Current medical diagnosis								
▪ Acute respiratory distress syndrome	**12.50±7.78**	**13.00±7.07**	**13.50±7.78**	**14.00±7.07**	**14.50±9.19**	**15.00±8.49**	**15.50±9.19**	**16.00±8.49**
▪ Poly trauma	8.39±2.50	8.50±2.83	9.39±2.50	9.50±2.83	9.56±2.41	9.72±2.70	0.67±2.40	10.72±2.70
▪ Acute respiratory failure	10.50±3.38	10.75±3.28	11.50±3.38	11.75±3.28	11.75±3.33	12.00±3.38	12.75±3.33	12.88±3.48
▪ Post-operative disorder	10.26±3.11	10.09±3.25	11.26±3.11	10.96±3.35	11.653.21	11.39±3.47	12.65±3.21	12.39±3.47
▪ Cerebrovascular accident	12.11±6.03	12.00±5.77	13.11±6.03	13.00±5.77	13.33±6.25	13.22±6.00	14.22±6.12	14.11±5.84
F , P	1.88 0.127	1.79 0.145	1.88 0.127	1.76 0.151	2.00 0.107	1.81 0.139	1.85 0.133	1.75 0.151
Body mass index								
▪ Normal	8.25±2.21	8.04±2.44	9.25±2.21	9.04±2.44	9.50±2.21	9.33±2.37	10.54±2.23	10.33±2.37
▪ Overweight	9.48±2.92	9.64±2.63	10.48±2.92	10.52±2.73	10.68±2.93	10.72±2.81	11.72±2.89	11.68±2.82
▪ Obese	**15.45±3.59**	**15.55±3.50**	**16.45±3.59**	**16.55±3.50**	**17.09±3.78**	**17.27±3.55**	**18.00±3.72**	**18.18±3.46**
F , P	**26.05 0.000***	**29.02 0.000***	**26.05 0.000***	**28.38 0.000***	**28.22 0.000***	**31.63 0.000***	**27.65 0.000***	**31.25 0.000***
Size of urinary catheter								
▪ 16 fr	9.85±4.26	9.96±3.96	10.85±4.26	10.89±4.03	11.11±4.37	11.19±4.20	12.19±4.34	12.19±4.20
▪ 18 fr	**10.62±3.49**	**10.59±3.81**	**11.62±3.49**	**11.55±3.81**	**12.00±3.64**	**11.97±3.90**	**12.97±3.56**	**12.90±3.84**
▪ 20 fr	7.75±1.71	7.25±1.26	8.75±1.71	8.25±1.26	8.75±1.71	8.25±1.26	9.75±1.71	9.25±1.26
F , P	1.10 0.341	1.39 0.258	1.10 0.341	1.34 0.269	1.33 0.273	1.61 0.209	1.29 0.283	1.56 0.220

* Statistically significant at level P<0.05

Table (8): Correlation between intra-abdominal pressure and respiratory dynamics of the studied critically ill patients

Intra-abdominal Pressure measurements		The studied patients (n=60) Respiratory dynamics															
		1st day								2nd day							
		Supine position				Right lateral position				Supine position				Right lateral position			
		0-angle		15-angle		0-angle		15-angle		0-angle		15-angle		0-angle		15-angle	
		Clt	Raw	Clt	Raw	Clt	Raw	Clt	Raw	Clt	Raw	Clt	Raw	Clt	Raw	Clt	Raw
1. Morning	R	**-0.405**	**0.514**	**-0.428**	**0.515**	**-0.408**	-0.027	-0.058	0.160	**-0.485**	**0.590**	**-0.486**	**0.585**	**-0.490**	**0.605**	**-0.480**	**0.600**
	P	**0.001****	**0.000****	**0.001****	**0.000****	**0.001****	0.835	0.659	0.223	**0.000****	**0.000****	**0.000****	**0.000****	**0.000****	**0.000****	**0.000****	**0.000****
2. Evening	R	**-0.403**	**0.510**	**-0.420**	**0.514**	**-0.406**	-0.028	-0.069	-0.055	**-0.486**	**0.594**	**-0.478**	**0.583**	**-0.507**	**0.600**	**-0.496**	**0.601**
	P	**0.001****	**0.000****	**0.001****	**0.000****	**0.001****	0.829	0.600	0.674	**0.000****	**0.000****	**0.000****	**0.000****	**0.000****	**0.000****	**0.000****	**0.000****

R: Pearson' correlation coefficient * Statistically significant at level P<0.05 ** Statistically highly significant at level P<0.01

Table (9): Correlation between hemodynamic parameters and intra-abdominal pressure of studied critically ill patients

Parameters		The studied patients (n=60) Intra-abdominal Pressure measurements															
		1st day								2nd day							
		Supine position				Right lateral position				Supine position				Right lateral position			
		0-angle		15-angle		0-angle		15-angle		0-angle		15-angle		0-angle		15-angle	
		Morning	Evening	Morning	Evening	Morning	Evening	Morning	Evening	Morning	Evening	Morning	Evening	Morning	Evening	Morning	Evening
1. Blood pressure																	
▪ Systolic	R	0.013	0.006	-0.033	-0.038	0.058	0.040	-0.094	-0.156	-0.131	-0.132	-0.177	-0.178	-0.095	-0.112	-0.148	-0.164
	P	0.922	0.963	0.800	0.771	0.659	0.760	0.476	0.235	0.319	0.316	0.176	0.175	0.468	0.394	0.259	0.211
▪ Diastolic	R	-0.156	-0.153	-0.207	-0.200	-0.144	-0.142	-0.100	-0.111	**-0.288**	**-0.286**	**-0.312**	**-0.322**	-0.246	**-0.277**	**-0.276**	**-0.315**
	P	0.233	0.242	0.112	0.126	0.272	0.280	0.445	0.397	**0.026***	**0.027***	**0.015***	**0.012***	0.058	**0.032***	**0.033***	**0.014***
2. Mean arterial pressure (MAP)	R	-0.094	-0.095	-0.129	-0.125	-0.052	-0.060	-0.094	-0.119	-0.242	-0.237	**-0.264**	**-0.272**	-0.203	-0.229	-0.184	-0.207
	P	0.475	0.472	0.326	0.343	0.693	0.650	0.475	0.366	0.063	0.068	**0.042***	**0.035***	0.120	0.078	0.159	0.113
3. Heart rate (HR)	R	-0.031	-0.041	-0.004	-0.016	-0.006	-0.015	-0.089	0.050	0.053	0.088	0.078	0.121	0.091	0.143	0.094	0.147
	P	0.813	0.757	0.977	0.906	0.964	0.907	0.501	0.705	0.688	0.503	0.555	0.356	0.488	0.275	0.475	0.262
4. Temperature (° c)	R	-0.141	-0.135	-0.141	-0.133	-0.160	-0.150	-0.144	0.074	-0.076	-0.070	-0.059	-0.058	-0.088	-0.103	-0.046	-0.071
	P	0.284	0.305	0.284	0.313	0.221	0.252	0.273	0.572	0.563	0.593	0.654	0.661	0.502	0.433	0.726	0.591
5. Respiratory rate (RR)	R	0.131	0.167	0.171	0.213	0.183	0.226	0.050	0.022	**0.338**	**0.321**	**0.364**	**0.354**	**0.376**	**0.383**	**0.360**	**0.384**
	P	0.320	0.177	0.193	0.102	0.162	0.083	0.705	0.865	**0.008****	**0.013***	**0.004****	**0.005****	**0.003****	**0.003****	**0.005****	**0.002****

R: Pearson' correlation coefficient * statistically significant at level P<0.05 ** statistically highly significant at level P<0.01

Discussion

The measurement of intra-abdominal pressure (IAP) is a vital hemodynamic monitoring method used in the ICU to identify patients at risk for intra-abdominal hypertension and subsequent abdominal compartment syndrome. IAP measurement is a rapid, safe, precise, and cost-effective method for diagnosing intra-abdominal hypertension, making it prevalent in clinical practice. In addition, the intra-abdominal pressure varies greatly depending on body position and bed head height **(Li et al., 2023; Samimian et al., 2021).**

Regarding age, the present result found that more than one third of subjects were between the ages of 50 and 60. From the viewpoint of the investigator this could be because of increased incidence of chronic diseases and ICU admission with advanced age. This result was confirmed by the research performed by **Chawada, Chavan, Pokharkar, Deshmukh & Jamdade, (2024)** who studied " A Cross-Sectional Study for Effect of IAP as A Factor for Abdominal Wound Dehiscence " and revealed that nearly one third of the sample were in 51-60 years old.

This conclusion was opposed by **Ahmad, (2023)**, who investigated the "Effect of head of bed elevation on IAP measurement among mechanically ventilated critically ill patients" and found that nearly one quarter of participants aged in the range between 41-50 years.

In relation to gender of studied patients, the recent study revealed that over fifty percent of the studied sample were male. From the researcher point of sight, male patients are admitted to the ICU more frequently than female patients; likely due to male patients participate in activities that result in elevated rates of illness and injury, such as chronic work-related stressors, smoking, and lifestyle choices. Furthermore, their genetic inheritance, hormonal profiles, and anatomy. This explanation was supported by **Hill et al., (2020)** who concluded that males were predominated in ICU admissions as they are at higher risk of getting several types of chronic diseases.

These findings also were agreed with the research performed by **Ahmad, (2023)** who revealed that above half of the subjects were males. Meanwhile, the recent study was incongruent with **Plešnik et al., (2025)** who concluded that above two thirds of subjects were females.

Concerning marital status of the studied patients, the finding of the current study found that more than half of the subjects were married. This may be explained by above one third of the subjects aged between 50 to 60 years old and this age is normally to be married. This result agreed with **Zakaria Lutfy Yassien, Hessein Nassr, Abdallah Abdelatief & Mohammed Khalifa Ewees, (2024),** who found that three quarters of the subjects were married.

Related to level of education, the present study revealed that more than one third of the subjects had secondary education. This finding was agreed with **Zakaria Lutfy Yassien, Hessein Nassr, Abdallah**

Abdelatief & Mohammed Khalifa Ewees, (2024), who found that less than one third of the study sample had secondary educational level.

Meanwhile, this finding disagreed with **Qurany Ahmed, Elsayed Mahdy, Nadr Ebraheim, Hussein Bakr & Sayed Abd El Mawla, (2024),** in a study entitled " Assessment of Gastrointestinal Outcomes among Intermittent Enterally Fed Critically Ill Patients" and showed that about one third of the studied subjects can't read and write.

As regard to current medical diagnosis, the present study showed that over one-third of the subjects were diagnosed with post-operative disorders, although fewer than one-third were classified as polytrauma cases. From the researcher's perspective, this outcome may be attributed to the nature of ICU admissions as emergencies, a rise in accidents, and an increased prevalence of chronic diseases among critically ill patients. This also might be because more than one half of subjects were males being more likely to engage in behaviors that increase their vulnerability to trauma (such as heavy work, fights, or even driving).

These findings were aligned with **Dukkipati et al., (2024),** who represented that almost all the participants were post-operative. Furthermore, these findings were in harmony with **Samimian, Khaleghdoost, Ashraf & Hakimi, (2021),** who found that less than two third of the studied subjects were diagnosed with trauma.

In contrast, these results were rejected by **AlJabri et al** who reported that almost one quarter of these individuals were diagnosed with acute respiratory distress syndrome (ARDS).

Pertaining to comorbidities and past medical history, the recent results found that less than half of subjects had past history for cardiovascular disorders. From the perspective of the investigator, this might as a result of most of the subjects were old aged so they were at higher risk for acquiring chronic diseases. This finding similar to **Ahmad, (2023)** who reported that two thirds of patients had past medical history for cardiovascular disorders.

In regard to body mass index, this current study revealed that over one-third of participants were classified as overweight. From the viewpoint of the investigator, this may be return to that the most of participants were elderly and that gaining weight is most common in adult over 50 years related to several causes including a decrease in resting metabolic rate, diminished physical activity, and age-related hormonal alterations. This finding in the same line with **Qurany Ahmed, Elsayed Mahdy, Nadr Ebraheim, Hussein Bakr & Sayed Abd El Mawla, (2024),** in a study entitled " Assessment of Gastrointestinal Outcomes among Intermittent Enterally Fed Critically Ill Patients " and revealed that almost two fifths of the participants were overweight.

Meanwhile, this finding disagreed with **Chawada, Chavan,**

Pokharkar, Deshmukh & Jamdade, (2024) who represented that less than two thirds of participants had normal BMI.

Regarding size of the catheter, it was determined that fewer than fifty percent of studied sample were catheterized using 18 Fr or 16 Fr catheter sizes. This may arise from the availability of equipment in the ICU and client's characteristics, including age, sex, and urethral diameter. This finding aligns with **Hak et al., (2022)** who demonstrated that most of the participants in both the control and trial groups were catheterized with a 16 Fr catheter size.

Concerning blood pressure, there was a statistically significant difference increase regarding SBP, DBP& MAP among the studied critically ill patients when the patient was in supine versus right lateral position at the head of bed (0&15) degree on the 2nd day. From the investigator's perspective, this may be attributed to supine positions decreasing the gravity influence on the human body, hence enhancing venous return to the heart, which subsequently elevates cardiac output and increases blood pressure.

The findings of the current study were accepted with **Ismail, Mohammad & Mourad, (2021)** who reported that it was observed that all hemodynamic measures exhibited a highly statistically significant rise in the mean scores between pre-position and post-position in both the left lateral and supine positions. Furthermore, illustrated that SBP, DBP, and MAP exhibit statistically significant reductions in the post position when in the right lateral and semi-Fowler positions. Conversely, these findings contradicted **Zhou et al., (2023)** who reported no significant variation in MAP across all angles of HOB.

While, regarding respiratory rate, the results indicated a statistically significant difference among the examined patients in the supine and right lateral positions at the head of the bed at 0 and 15 degrees on the first and second days. Moreover, there was a highly statistically significant difference increase in respiratory rate (RR) among the studied critically ill patients when the patient was in supine versus right lateral position at the head of bed (0&15) degree in the 1st and the 2nd day of the study. From the researcher's perspective, this finding may be associated with the benefits of deep breaths at an elevated head-of-bed position, counteracting the propensity for airway closure due to alterations in lung compliance and pressure from lower abdominal organs on the diaphragm. These findings were similar to the study conducted by **Ahmad, (2023)** who revealed that respiratory rate (RR) decreased at most different HOB angles. RR significantly decreased differences at 15°, 30°.

Furthermore, this result was agreed with **Ismail, Mohammad & Mourad, (2021)** who reported that the mean score of respiratory rates (RR) in the left lateral position and supine position increased between pre-position and post-position in a highly statistically significant. Additionally, it was revealed that the RR in post position in right lateral and semi fowler position decreased statistically significantly.

Concerning IAP measurements at different body positions, the findings of the present study demonstrated a rise in the mean IAP in both the supine and right lateral positions at a 15-degree angle. Furthermore, it was shown that there were no statistically significant variations in IAP measures between the supine and right lateral positions on the first and second days of implementation. From the investigator's perspective, elevating the head of the bed resulted in heightened IAP due to a redistribution of abdominal contents and augmented resistance from the abdominal wall. When the body is in an upright position, gravity induces the descent of abdominal contents, exerting pressure on the abdominal cavity. Additionally, the abdominal muscles may contract to maintain posture, further increasing IAP.

The result of the current study matched with the study by **Ahmad, (2023)** who concluded that the patient's body position changing from supine to higher positions result in increase of intraabdominal pressure with not a statistically significant difference in the measurement values IAP supine position, HOB elevation 15° and 30°. Additionally, these findings were in agreement with **Samimian et al., (2021)** who reported that the mean of the IAP increased at 15° and 30° with not a statistically significant difference in the measurement values IAP supine position, HOB elevation 15° and 30°.

On the other hand, these results were disagreed with **Zhou et al., (2023),** who found that there was a statistically significant increase in the IAP measurements when the HOB angle was changed from 0° to 15°. Moreover, these results were incompatible with **Mahran, Abd-Elshafy, Abd El Neem & Sayed, (2018),** It was determined that the mean and standard deviation of IAP improved after transitioning from the reference supine position to the right lateral position, with a statistically significant difference observed.

Regarding respiratory dynamics measurements, these findings were found that there was a significant difference regarding lung compliance (Clt) between the studied individuals in the supine and right lateral position at the head of the bed (0&15) degree on the 1st and the 2nd day. Also, it was found that there was a statistically significant difference increase in lung compliance (Clt) among the studied critically ill patients in the supine versus right lateral position at the head of bed (15) degree in the 1st and the 2nd day. While there was a statistically significant difference decreased in airway resistance (Raw) among the studied subjects in the supine versus right lateral position at head of the bed (15) degree in the 1st and the 2nd day.

The results of this study were agreed with **Ahmad, (2023)** who reported that tidal volume (Vt) and dynamic lung compliance were increased significantly with all of different

HOB angles 15°, 30°, and 45°. While the mean of the positive inspiratory pressure (PIP) decreased to HOB 15° than 0° with not a statistically significant difference.

Conversely, these findings incongruent with **Roldán et al., (2022),** who revealed that respiratory system compliance reduced when changing position from the supine to Lateral position, indicating a 53 mL/cmH_2O drop in chest wall compliance without changes in lung compliance. As well, these results are different from the study performed by **Elzohry, Abd El Khalik & Ismael Roushdy, (2020)** demonstrated that the supine position (lying flat) or lateral position did not influence respiratory mechanics in critically ill cases.

Concerning correlation between clinical data and IAP, the present study demonstrated that the highest mean IAP values were recorded in the supine and right lateral positions at a 15-degree angle at the head of the bed on the first and second days of implementation for individuals with ARDS, with no statistically significant correlation observed between medical diagnosis and IAP. From the viewpoint of the investigator, this could be because acute respiratory distress syndrome ARDS can cause increased stiffness of the chest wall (due to factors like lung edema and inflammation), which can increase the pressure within the abdomen.

The present study's findings were matched with those of **Samimian et al., (2021),** who identified elevated IAP in non-trauma participants relative to trauma patients. A strong association was identified between IAP and illness diagnosis.

Regarding correlation between BMI and IAP, the highest mean score of IAP measurements at supine and right lateral position at head of bed at (0&15) degree was seen with the Obese patients in the 1^{st} & 2^{nd} day of implementation. Moreover, this result showed a highly significant difference were found in the mean score of IAP& BMI in the 1^{st} & 2^{nd} day. From the researcher's point of view obese patients typically have abnormally high IAPs because of an increase in the volume of their abdominal or retroperitoneal contents, which is most likely the result of fatty deposits. This higher IAP is subsequently transported to the surrounding organs and cavities. Abdominal fat tissue (central obesity) appears to elevate IAP in individuals with elevated BMI through a direct impact on the abdominal cavity and pelvic floor.

The results of this study were in the same line with the study that was entitled by **Ahmad, (2023)** who showed that BMI was positively correlated with IAP. Meanwhile, these results were incongruent with **Gad, Ali & Sayed, (2025),** who concluded that the correlation between elevated IAP and BMI was not statistically significant.

As regard with correlation between intra-abdominal pressure and respiratory dynamics, it was found that there is a highly statistically significant negative correlation between IAP measurements and lung compliance (CLt). Moreover, there was a highly significant positive correlation between IAP measurements and airway resistance (Raw) throughout all the period of the study. whereby a rise in IAP causes a decrease in lung compliance while increasing airway resistance. This could be because the high IAP compresses the diaphragm and thoracic cavity therefore, intra-thoracic pressures increased, which hindering lung expansion, makes breathing harder, and reduces lung volumes and compliance.

These results in the same line with **Tayebi et al., (2025),** who found patients with intra-abdominal hypertension had lower abdominal compliance and dynamic respiratory compliance compared to patients without IAH. Likewise, these results were aligned with **Kutluay& Akbudak, (2024),** It was indicated that a correlation exists between IAP and respiratory parameters, wherein elevated levels of P-Peak, P-Plato, P-Drive, and PEEP are related with intra-abdominal hypertension.

Related to correlation between hemodynamic parameters and intra-abdominal pressure, this study demonstrated a statistically significant negative correlation between **IAP** measures and DBP in the supine and right lateral positions at degrees 0 and 15 on the second day of the study. A statistically significant negative correlation was discovered among the subjects in the supine position at 15 degrees for **IAP** measures and **MAP** on the second day. Simultaneously, a highly significant positive association was identified between IAP and RR in the supine and right lateral positions at degrees (0 and 15) on the second day of the investigation. From the researcher's perspective, this may be attributed to increased IAP, which results in increased intrathoracic pressure, diminished venous return to the heart, a drop in blood pressure and MAB, and an increase in RR. These results were matched with the study conducted by **Regli, Pelosi & Malbrain, (2019)** who found that elevated **IAP** led to a decrease in **MAP**. Also, **Samimian et al., (2021)** reported that **MAP** and **IAP** also significantly correlated with each other at the three angles (0°, 15° and 30°). In addition, these results were in the same line with the study performed by **Jang et al., (2018),** who showed that the respiratory rate (RR) raised significantly when IAP was elevated to 15, 20, and 25mmHg. On the opposite side, these findings were incongruent with **Hamoud, Abdelgani, Mekel, Kinaneh & Mahajna, (2022),** who revealed that the MAP increased statically significantly when the IAP was raised to 15 mmHg while the patient was in the supine position.

Conclusion

The findings of this study indicate that there is an elevation in the mean IAP in the supine and right lateral positions at a 15-degree angle, with no statistically significant difference in IAP values when elevating the head of the bed (HOB) angle from 0° to 15° in these positions. Also, there were no significant differences between IAP measurements in the supine position versus right lateral position.

Recommendations

- Further studies are needed to assess the various methods of intra-abdominal pressure measurements.
- The study should be replicated on large probability sample on different setting to generalize results.

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