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Risk Factor Analysis of Post-Operative Acute Respiratory Distress Syndrome in Valvular Heart Surgery

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Abstract: **Background: Acute respiratory distress syndrome (ARDS) is a major complication following cardiac surgery, particularly in patients undergoing valvular heart procedures. ARDS is associated with significant morbidity, increased hospital costs, and high mortality rates, ranging from 40% to 80%. Despite advances in perioperative care, the pathophysiology and risk factors of ARDS in patients undergoing isolated valvular heart surgery remain incompletely understood.**

Objective: This study aims to assess the incidence, severity, and outcomes of postoperative ARDS in patients undergoing isolated valvular heart surgery. Additionally, it seeks to identify potential risk factors associated with the development of ARDS in this patient population.

Methods: A prospective study will be conducted on 50 patients undergoing isolated valvular heart surgery at Mahalla Cardiac Center. Clinical assessment, radiological imaging, and laboratory investigations will be utilized to diagnose ARDS based on the Berlin criteria. Statistical analysis will be performed to identify significant predictors of ARDS, including preoperative, intraoperative, and postoperative variables.

Expected Outcomes: This study will provide valuable insights into the incidence and predictors of ARDS in isolated valvular heart surgery. Identifying modifiable risk factors may contribute to the development of targeted prevention strategies, ultimately improving patient outcomes and reducing healthcare burdens.

Conclusion: A deeper understanding of ARDS risk factors in valvular heart surgery patients will help refine perioperative management strategies, mitigate complications, and enhance overall patient care.

Keywords: **Acute respiratory distress syndrome (ARDS), cardiac surgery, heart surgery, healthcare burdens.**

1. INTRODUCTION

Acute Respiratory Distress Syndrome (ARDS) is a severe form of respiratory failure characterized by hypoxemia, bilateral lung infiltrates, and non-cardiac pulmonary edema. It is a leading cause of post-operative hypoxemic respiratory failure, with a mortality rate of approximately 40% (Fernandez-Perez et al., 2009; Kogan et al., 2014).

Cardiac surgery, particularly valvular heart surgery, is a significant risk factor for ARDS, affecting 4% to 20% of patients. The mortality rate in these cases can approach 80% (Stephens et al., 2013; Milot et al., 2011).

The 2012 Berlin definition of ARDS provides a more accurate framework for diagnosing and predicting outcomes in ARDS, addressing limitations of previous definitions (Ranieri et al., 2012).

Aim of the Work

The primary aim of this study is to investigate the incidence, severity, and outcomesof post-operative ARDS in patients undergoing isolated valvular heart surgery. Additionally, the study seeks to identify risk factors associated with the development of ARDS in this patient population.

2. SUBJECTS AND METHODS

Study PopulationThe study will include 50 patients undergoing valvular cardiac surgery at Mahalla Cardiac Center.

Inclusion Criteria:

Age between 16 and 65 years.

Patients admitted for isolated valvular cardiac surgery.

Exclusion Criteria:

Age <16 or >65 years.

Patients requiring emergent operations.

Patients on preoperative mechanical ventilation.

Assessments:

Clinical Assessment: Comprehensive history and physical examination.

Radiological Investigations: Chest X-ray and echocardiography.

Laboratory Investigations: Total leucocyte count, kidney function tests, and other relevant biomarkers.

3. RESULTS

The results will be tabulated and statistically analyzed to determine the incidence of ARDS, its severity, and associated outcomes. Statistical analysis will be performed using SPSS software.

4. DISCUSSION

The discussion will focus on interpreting the results in the context of existing literature, identifying key risk factors, and exploring potential strategies for prevention and management of ARDS in valvular heart surgery patients.

Ethics and Consent

Informed Consent: Participants will be fully informed about the study's merits and risks, and written consent will be obtained.

Confidentiality: Patient data will be anonymized using code numbers to ensure privacy.

Risks: No significant risks are expected, but any unexpected risks will be promptly communicated to participants and the ethical committee

Chapter 1: Pulmonary Pathophysiology of Cardiac Surgery Patients - Anatomy and Physiology:

The respiratory system includes the nasal cavity, pharynx, larynx, trachea, bronchi, and lungs. The diaphragm and intercostal muscles play crucial roles in breathing (Stoelting & Hiller, 2006).

Lung Volumes and Capacities: Key measurements include tidal volume (VT), inspiratory reserve volume (IRV), expiratory reserve volume (ERV), and functional residual capacity (FRC). These volumes are critical for understanding respiratory mechanics (Sherwood, 2000).

Effects of Anesthesia:

Anesthesia can impair central respiratory regulation, reduce lung volumes, and increase the risk of atelectasis and hypoxemia (Hedenstierna & Rothen, 2012).

Functional Residual Capacity (FRC) decreases by 15-20% during anesthesia, leading to alveolar collapse and increased shunt fraction (Reynolds, 2004).

Chapter 2: ARDS Risk Factors in Isolated Valvular Heart Surgery - Preoperative Risk Factors:

Cardiopulmonary Bypass (CPB): CPB triggers a systemic inflammatory response, leading to complement activation and neutrophil accumulation in the lungs, which can cause diffuse pulmonary injury (Asimakopoulos et al., 1998; Chenoweth et al., 1981).

Type of Valve Surgery: Tricuspid valve surgery is associated with higher mortality rates compared to other valve surgeries (McGrath et al., 1990; Scully et al., 1995).

Liver Disease: Patients with liver cirrhosis are at higher risk for ARDS due to increased systemic inflammation and pulmonary microvascular permeability (Milot et al., 2001).

Drugs: Amiodarone, commonly used for arrhythmias, can induce pulmonary toxicity and ARDS, especially with prolonged use (Boriani et al., 2012).

Intraoperative Risk Factors:

Blood Transfusions: Transfusion-related acute lung injury (TRALI) is a significant risk factor, with an incidence of up to 15% in cardiac surgery patients (Vlaar et al., 2011; Stephens et al., 2013).

Chapter 3: Management of ARDS After Cardiac Surgery - Prediction Scores:

The Lung Injury Prediction Score (LIPS) and Surgical Lung Injury Prediction (SLIP) models help identify patients at high risk for ARDS (Gajic et al., 2011; Kor et al., 2014).

Prevention:

Pre-emptive Lung-Protective Ventilation: Low tidal volumes and appropriate positive end-expiratory pressure (PEEP) can reduce the incidence of ARDS (Serpa Neto et al., 2015).

Biomarkers:

Receptor for Advanced Glycation End Products (RAGE)and other biomarkers may help diagnose and predict ARDS (Ware & Calfee, 2015).

Management:

Lung-Protective Ventilation: Low tidal volumes (6 ml/kg predicted body weight) and limited plateau pressures (<28–30 cm H2O) are standard (Oh et al., 2013).

Prone Positioning: Improves oxygenation and reduces mortality in severe ARDS, especially when combined with low tidal volume ventilation (Sud et al., 2014; Beitler et al., 2014).

Extracorporeal Membrane Oxygenation (ECMO): Used in life-threatening cases as a bridge to recovery (Leligdowicz & Fan, 2015).

Fluid Management: Conservative fluid strategies improve outcomes, but must be balanced against the risk of renal dysfunction (Mikkelsen et al., 2012).

Transfusion Strategies: Optimized transfusion protocols reduce the risk of TRALI (Vlaar et al., 2011).

Neuromuscular Blockade: May reduce ventilator-induced lung injury in severe ARDS (Forel et al., 2006).

Inhaled Pulmonary Vasodilators: Limited benefit, with potential risks such as renal dysfunction (Adhikari et al., 2014).

Novel Therapies: Mesenchymal stem cell therapy and statins are under investigation but lack proven benefits (Wilson et al., 2015; McAuley et al., 2014).

5. CONCLUSION

ARDS remains a significant complication of valvular heart surgery, with high mortality rates. Identifying risk factors such as CPB, blood transfusions, and liver disease, and implementing preventive strategies like lung-protective ventilation and optimized transfusion protocols, are crucial for improving outcomes. Further research is needed to refine prediction models and develop effective therapies for ARDS.

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[5] Vlaar et al., 2011: Transfusion-related acute lung injury (TRALI) in cardiac surgery.

[6] Sud et al., 2014: Prone positioning in ARDS.

[7] McAuley et al., 2014: Statins in ARDS.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Age	50	33	70	49.24	9.958
BMI	50	22.5	34.1	28.040	3.1019
LVEF (%)	50	32.00%	59.00%	46.9000%	7.06313%
CPB Duration (min)	50	85	175	123.10	28.924
Mechanical Ventilation Duration (Hours)	50	14	68	40.08	16.646
Valid N (listwise)	50				

Statistics

		Age	BMI	LVEF (%)	CPB Duration (min)	Mechanical Ventilation Duration (Hours)
N	Valid	50	50	50	50	50
	Missing	0	0	0	0	0

Statistics

		Gender	Smoking Status	COPD (1/2)	Previous Cardiac Surgery (1/2)	Liver Disease (1/2)	Preop Ventila
N	Valid	50	50	50	50	50	
	Missing	0	0	0	0	0	

		Age	BMI	LVEF (%)	CPB Duration (min)	Mechanical Ventilation Duration (Hours)
N	Valid	50	50	50	50	50
	Missing	0	0	0	0	0

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	26	52.0	52.0	52.0
	2	24	48.0	48.0	100.0
	Total	50	100.0	100.0	

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Smoking Status

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	21	42.0	42.0	42.0
	2	12	24.0	24.0	66.0
	3	17	34.0	34.0	100.0
	Total	50	100.0	100.0	

COPD (1/2)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	23	46.0	46.0	46.0
	2	27	54.0	54.0	100.0
	Total	50	100.0	100.0	

Previous Cardiac Surgery (1/2)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	19	38.0	38.0	38.0
	2	31	62.0	62.0	100.0
	Total	50	100.0	100.0	

Liver Disease (1/2)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	18	36.0	36.0	36.0
	2	32	64.0	64.0	100.0
	Total	50	100.0	100.0	

Preoperative Ventilation (1/2)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	18	36.0	36.0	36.0
	2	32	64.0	64.0	100.0
	Total	50	100.0	100.0	

Type of Surgery

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	15	30.0	30.0	30.0
	2	20	40.0	40.0	70.0
	3	15	30.0	30.0	100.0
	Total	50	100.0	100.0	

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Postoperative Infections (1/2)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	24	48.0	48.0	48.0
	2	26	52.0	52.0	100.0
	Total	50	100.0	100.0	

Postoperative Low Cardiac Output (1/2)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	22	44.0	44.0	44.0
	2	28	56.0	56.0	100.0
	Total	50	100.0	100.0	

Hypoxia Severity

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	13	26.0	26.0	26.0
	2	17	34.0	34.0	60.0
	3	20	40.0	40.0	100.0
	Total	50	100.0	100.0	

ARDS Incidence (1/2)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	24	48.0	48.0	48.0
	2	26	52.0	52.0	100.0
	Total	50	100.0	100.0	

ARDS Severity (3/1/2)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	35	70.0	70.0	70.0
	2	12	24.0	24.0	94.0
	3	3	6.0	6.0	100.0
	Total	50	100.0	100.0	

Survival Status (1/1)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	50	100.0	100.0	100.0

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ICU Stay Duration (Days)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5	1	2.0	2.0	2.0
	6	6	12.0	12.0	14.0
	7	6	12.0	12.0	26.0
	8	2	4.0	4.0	30.0
	9	2	4.0	4.0	34.0
	10	1	2.0	2.0	36.0
	11	1	2.0	2.0	38.0
	12	5	10.0	10.0	48.0
	14	3	6.0	6.0	54.0
	15	5	10.0	10.0	64.0
	16	1	2.0	2.0	66.0
	17	1	2.0	2.0	68.0
	18	2	4.0	4.0	72.0
	19	1	2.0	2.0	74.0
	21	1	2.0	2.0	76.0
	22	1	2.0	2.0	78.0
	23	1	2.0	2.0	80.0
	25	2	4.0	4.0	84.0
	27	2	4.0	4.0	88.0
	28	4	8.0	8.0	96.0
	30	2	4.0	4.0	100.0
	Total	50	100.0	100.0	

Emergency Surgery (1/2)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	20	40.0	40.0	40.0
	2	30	60.0	60.0	100.0
	Total	50	100.0	100.0	

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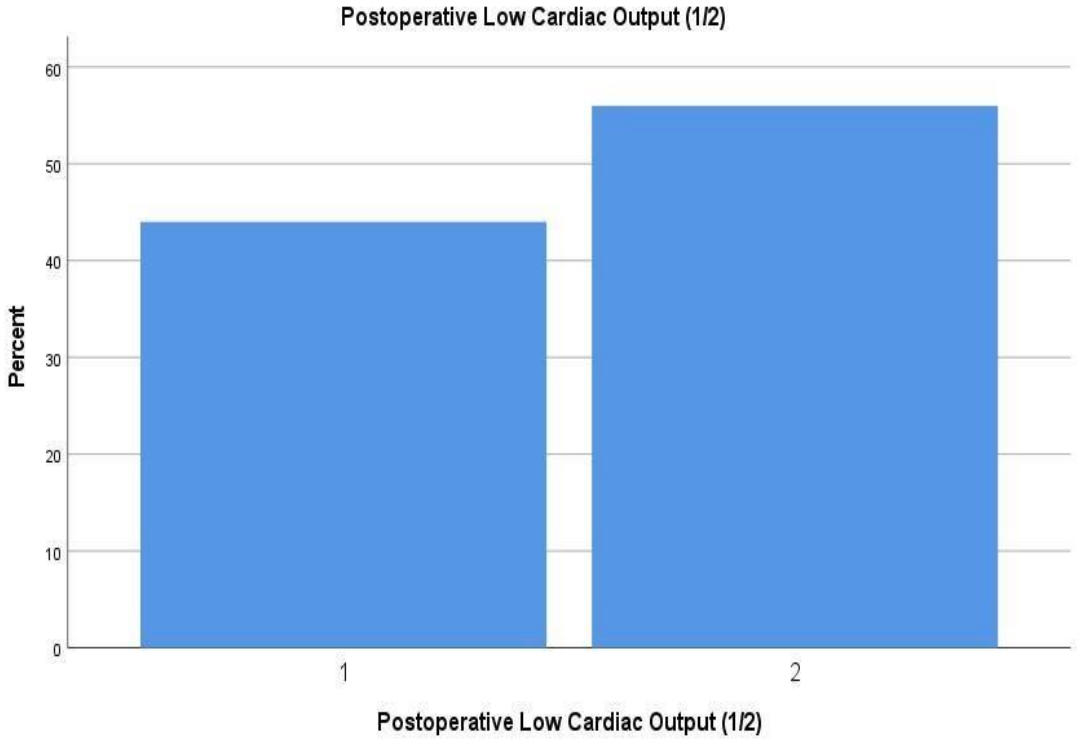
Blood Transfusions (Units)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	9	18.0	18.0	18.0
	1	5	10.0	10.0	28.0
	2	13	26.0	26.0	54.0
	3	12	24.0	24.0	78.0
	4	9	18.0	18.0	96.0
	5	2	4.0	4.0	100.0
	Total	50	100.0	100.0	

Anesthesia/ Medications

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	20	40.0	40.0	40.0
	2	15	30.0	30.0	70.0
	3	15	30.0	30.0	100.0
	Total	50	100.0	100.0	



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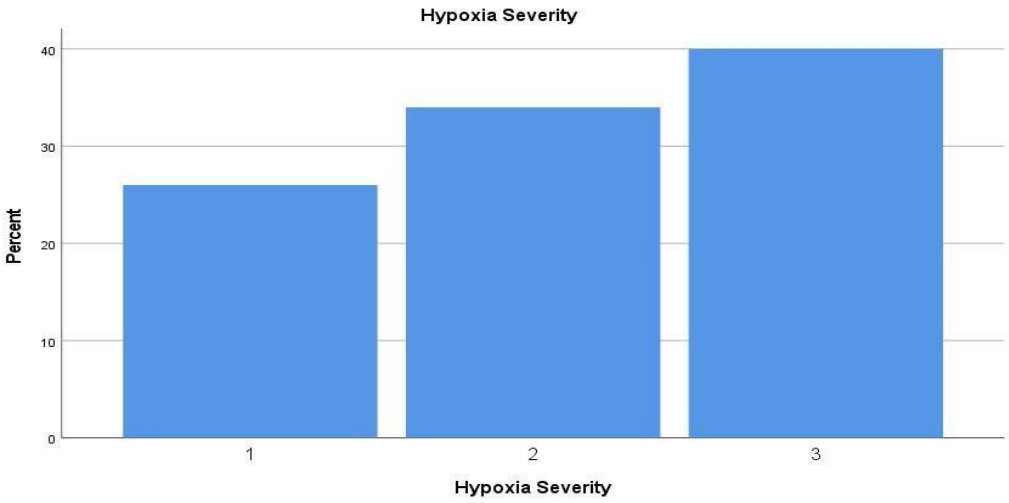

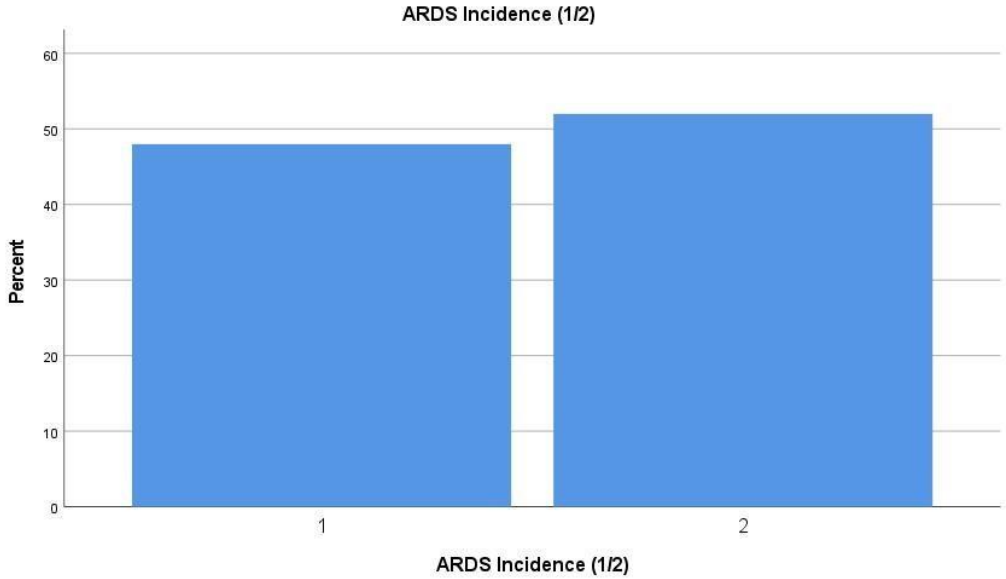

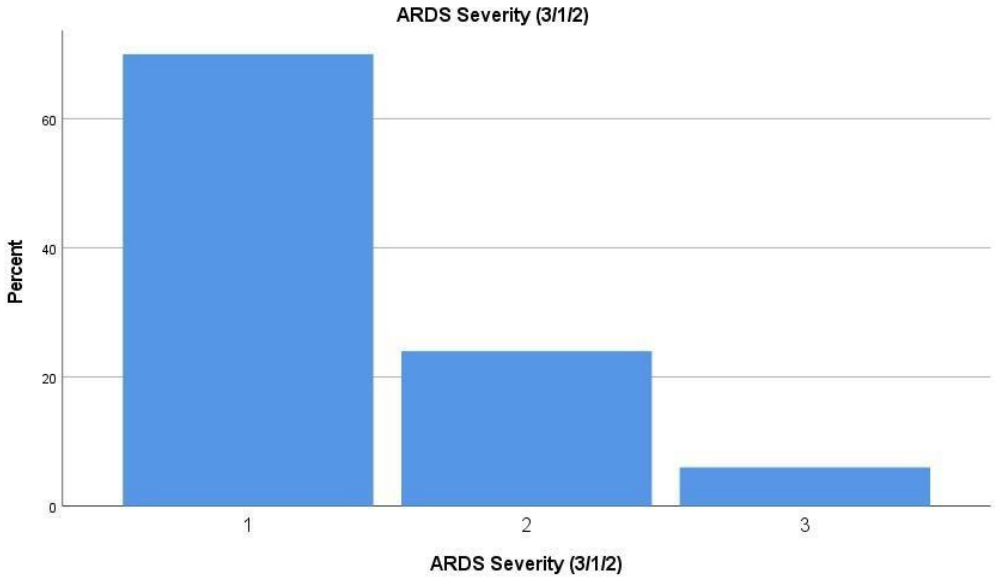

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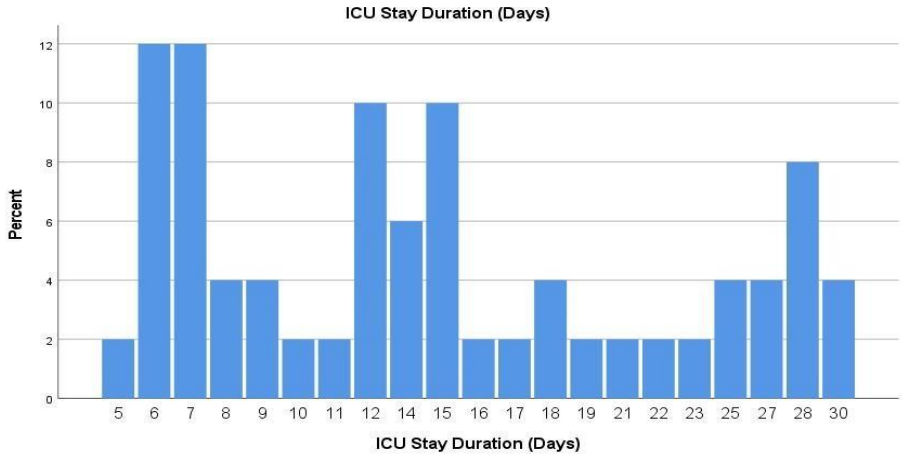
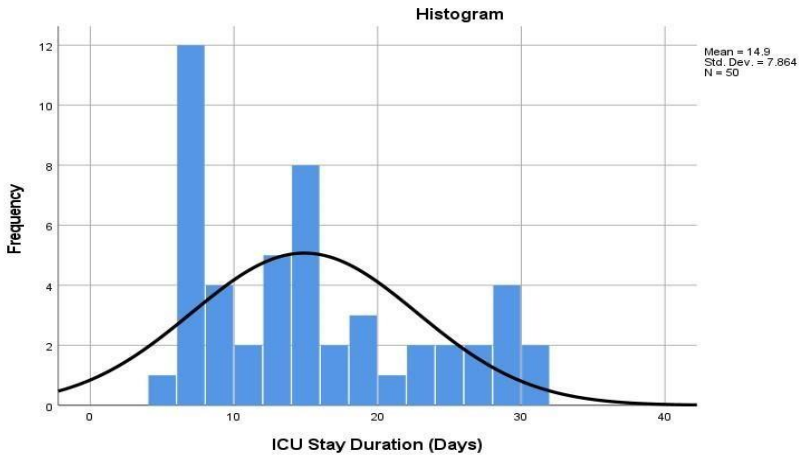


Statistics

ICU Stay Duration (Days)

N	Valid	50
	Missing	0
Mean		14.90
Std. Deviation		7.864
Minimum		5
Maximum		30



Statistics

Blood Transfusions (Units)

N	Valid	50
	Missing	0
Mean		2.26
Std. Deviation		1.454
Minimum		0
Maximum		5