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Risk Factors Associated with Acute Respiratory Distress Syndrome in Pediatrics

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ABSTRACT

Background: Every expectant mother hopes for a healthy baby, yet complications during delivery can lead to severe conditions like acute respiratory distress syndrome (ARDS). This study aims to identify key risk factors associated with ARDS in pediatric patients. **Methodology:** A questionnaire was developed through a literature review to identify key ARDS risk factors in pediatrics. The questionnaire was verified by a panel of pediatric experts, and its reliability was tested (Cronbach's alpha = 0.5). **Results:** Among the infants, 55% were male and 45% female. APGAR scores showed 36% had mild depression, 46% moderate, and 18% severe asphyxia. Mechanical ventilation was required for 40% of patients. Preterm births accounted for 67.13% of cases, while 64.3% were term and 8.4% late-term. C-section deliveries were common (65.03%), and 41% of patients had raised bilirubin levels. Only 20% were breastfed, while 58% required nasogastric tubes. Most patients (81.82%) were aged 1 day to 1 month. Hospital stays varied: 35% in days, 46% in weeks, and 19% in months. Advanced Cardiac Life Support was needed for 29%, and blood transfusions for 24%. Ventilator modes varied, with nasal cannula (45%) being the most used. PaO_2/FiO_2 ratios were normal in 29%, mild in 33%, moderate in 21%, and severe in 17%. Mortality was 24%. **Conclusion:** Preterm birth and mechanical ventilation were the major risk factors for pediatric ARDS. Sepsis, HIE II & III, pneumonia, metabolic disorders, and meconium aspiration were prevalent diagnoses.Surfactant therapy was associated with a 68% mortality rate, emphasizing its impact on lung maturity.

INTRODUCTION

In the original description of what Ashbaugh and colleagues described as "the acute respiratory distress syndrome in adults" in 1967, special attention was paid to the inciting illness or injury (e.g., severe trauma, viral infection, acute pancreatitis) and possible contributing factors (e.g., hypotension, acidosis, fluid overload)(1,2). Interestingly, of the 12 patients that Ashbaugh and colleagues described in that article, 4 of the 12 were aged 19 years or younger and may have been managed in pediatric critical care units today. That initial description has since evolved into the American European Consensus Conference (AECC) definition in 1994 and then the current Berlin definition of ARDS for adults and the Pediatric Acute Lung Injury Consensus Conference (PALICC) definition of pediatric ARDS (PARDS) (3, 4). Throughout these iterations, much attention continues to be paid toward understanding what conditions place patients at particular risk for ARDS development and what conditions contribute to worse ARDS clinical outcomes. This intense work is imperative in order to identify potentially modifiable factors that would decrease risk, improve monitoring of at-risk patients to prevent precipitous deterioration, and ultimately determine more personalized and precise approaches to management of those at highest risk or those with ARDS once established(4-6).

Risk factors associated with acute respiratory distress syndrome, whether in adults (ARDS) or pediatrics (PARDS), traditionally and originally consisted of the *diagnoses most often associated with ARDS or PARDS development.* This chapter takes these diagnoses into great account. Fortunately, this field of

research has expanded to include relevant *comorbidities* associated with ARDS/PARDS development and/or severity(7,8). As the last 30 years have yielded important understanding into the pathobiology of ARDS/PARDS, so too have *biological markers* (aka biomarkers) and *markers associated with genetic risk* of ARDS/PARDS come to the forefront. Finally, discussions of ARDS/PARDS risk factors must inevitably dissect out whether the risk factors are associated with the *development* of ARDS/PARDS, and thereby factors impacting those patients *at risk of ARDS/PARDS development*, as well as those factors associated with better or worse *clinical outcome* once ARDS/PARDS has been established(9).

Finally, much of this work has now demanded that both clinicians and researchers refine our discourse to further acknowledge that, as a syndrome, certain subgroups of patients, oft termed endotypes or sub-phenotypes, must exist that ultimately can be at inherently greater risk of disease and/or have unique pathophysiological responses that may make these subgroups of patients more or less able to respond to certain treatment strategies(9-11). Accordingly, describe factors associated with subgroups of patients at inherently greater risk of ARDS/PARDS, whereas identify subgroups of patients that are at greater/lesser likelihood of responding to certain treatment strategies based on inherent differences in their underlying pathophysiologic responses to illness/injury. ARDS is one of the most challenging pathologies to manage in critical care medicine. There is no specific treatment, the management is primarily based on supportive care. The goal is to try and protect the lungs from any further injury (12,13).

In paediatric practice the challenges are even greater due to the overlap of diseases especially chronic lung disease, congenital heart defects and bronchiolitis(14). The recent PARDIE (paediatric acute respiratory distress syndrome incidence and epidemiology) study, reported an incidence of 3.2% of paediatric ARDS (PARDS) admitted to PICU and 6.1% among those on mechanical ventilation. The mortality is still high and varies between 17% and 32%. Early recognition and intervention may help improve the outcome of children with PARDS. Very Limited studies on this topic are available in our population, & my aim to identify the risk factors associated with acute respiratory distress syndrome in pediatric patients. The purpose of the study is to determine the disease severity of acute respiratory distress syndrome from birth to one year of infants. It will help to improve the prognosis of patients following acute respiratory distress syndrome and in the long term decrease mortality of this group of patients in Pakistan. The main of this study is to identify the risk factors associated with ARDS in pediatric patients in Lahore tertiary hospitals.

MATERIALS AND METHOD

Study Design and Setting

This observational cross-sectional study was conducted to assess acute respiratory distress syndrome (ARDS) in infants admitted to the Department of Pediatric Intensive Care Units (PICU) I and II at Lahore General Hospital, Punjab, Pakistan. The study population comprised suspected or confirmed cases of ARDS in infants admitted from the nursery or emergency to PICU. Lahore General Hospital, a 1600-bed tertiary care hospital, serves a large population, with the metro area population of Lahore estimated at over 13 million in 2024. The study spanned four months after the synopsis approval, during which data was collected under the supervision of Prof. Dr. Muhammad Shahid, Head of Pediatrics at Lahore General Hospital.

Study Duration and Sampling Technique

The study was conducted over four months following ethical approval from the Department Research Committee of the Superior University. A convenient sampling technique was employed to recruit participants. The sample size, calculated with a 7% precision, a 24% prevalence, and a 95% confidence interval, included 143 participants.

Sample Selection

Inclusion Criteria

- Infants diagnosed with ARDS.
- Participants of both genders from birth to 1 year.

Exclusion Criteria

- Toddlers and adults.
- Patients without respiratory diseases.

Equipment

The pediatric department had 60 beds distributed across ICU, medical wards, and emergency wards. Neonatal care facilities included 5 warmers, 8 cots, and 3 incubators. Essential equipment included ventilators, apnea monitors, pulse oximeters, nebulizers, infusion pumps, and phototherapy units. A recent Retinopathy of Prematurity (ROP) program, run jointly with the eye department, was also established.

Ethical Considerations

Ethical approval was obtained from Superior University Research Committee. Written informed consent was acquired from participants' guardians, and confidentiality was strictly maintained. Participants remained anonymous throughout the study and were free to withdraw at any time. Data was securely stored, both digitally and physically, to ensure privacy.

Data Collection Procedure

Study variables, including independent and dependent variables, were identified through literature reviews and

expert consultations. Data collection involved infants admitted to PICU I and II via nursery or emergency. A validated questionnaire was developed and used to gather key risk factors associated with ARDS in pediatric patients.

Data Analysis

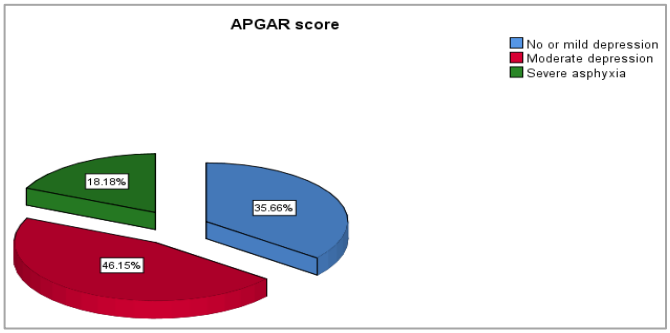
Data analysis was performed using IBM SPSS Version 26. Descriptive statistics were used to summarize data, while Bayesian ANOVA, cross-tabulations, and chi-square tests were applied for inferential analysis. The results were represented in tables and charts, and confidence intervals were calculated with a 7% precision and 24% prevalence.

Results

After APGAR scoring, we got a result for 143 patients, no or mild depression was thirty-six percent (51), moderate depression forty-six (66) & severe asphyxia was eighteen (26).

Figure1

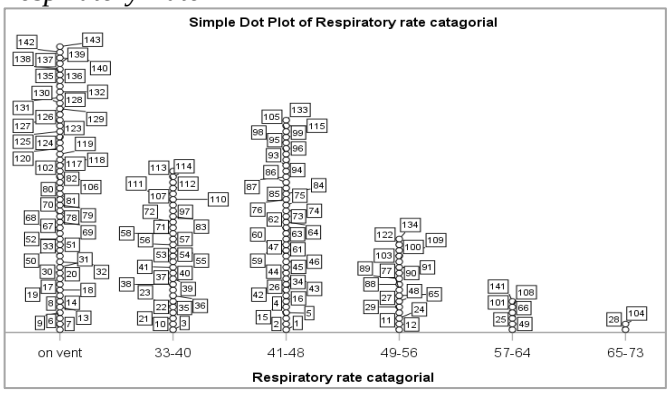
APGAR Score



The result had collected 143 patients in which six classes included those who on vent 35.7% (51) of infants, those who had 33-40 RR was 20.3% (29), 41-48 RR 26.6% (38), 49-56 RR 11.9% (17), 57-64 RR 4.2% (6), 65-73 RR 1.4% (2).

Figure 2

Respiratory Rate



The Bayesian estimates indicate the effect of different ventilator modes on the APGAR score, with posterior modes and means showing similar values, suggesting stable estimates. The highest posterior mode is for Ambu bag (2.556), implying the strongest association with APGAR score, followed by BiPAP (2.143) and SIMV (2.051), while the lowest is for "Not need" (1.250), indicating the weakest association. The 95% credible intervals suggest varying degrees of uncertainty, with Ambu bag having the widest interval (2.007–3.104), indicating more variability, whereas concentrated oxygen through a nasal cannula has the narrowest (1.393–1.744), indicating more precise estimation. The inclusion of gender as a regression weight variable suggests potential adjustment for sex-related differences in outcomes.

Table 1

Bayesian Estimates of Coefficients

Bayesian Estimates of Coefficients[a,b,c,d]

Parameter	Posterior			95% Credible Interval	
	Mode	Mean	Variance	Lower Bound	Upper Bound
Ventilator mode preference according to ABGs & PEEP adjustment = Not need	1.250	1.250	.176	.428	2.072
Ventilator mode preference according to ABGs & PEEP adjustment = PC-CMV	1.969	1.969	.022	1.678	2.260
Ventilator mode preference according to ABGs & PEEP adjustment = CPAP	1.952	1.952	.033	1.593	2.311
Ventilator mode preference according to ABGs & PEEP adjustment = BiPAP	2.143	2.143	.050	1.703	2.582
Ventilator mode preference according to ABGs & PEEP adjustment = SIMV	2.051	2.051	.018	1.788	2.315
Ventilator mode preference according to ABGs & PEEP adjustment = Concentrated oxygen through nasal cannula	1.568	1.568	.008	1.393	1.744
Ventilator mode preference according to ABGs & PEEP adjustment = Ambu bag	2.556	2.556	.078	2.007	3.104

a. Dependent Variable: APGAR score

b. Model: Ventilator mode preference according to ABGs & PEEP adjustment

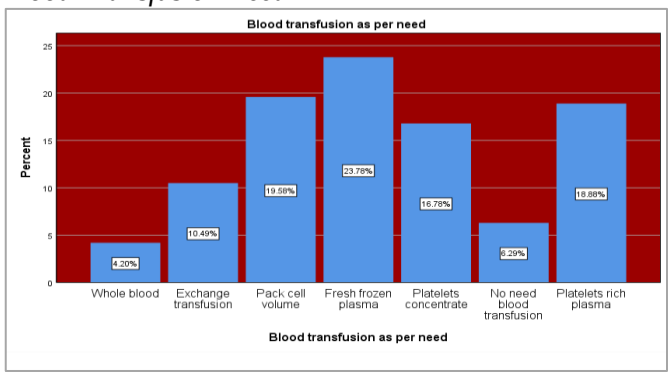
c. Regression Weight Variable: Gender

d. Assume standard reference priors.

Blood transfusion as per need had FFP was 23.78% (34), PCV were 19.58% (28), no needed of blood transfusion because all parameter completely hose needed other conventional therapy and nourishment was 6.29% (9), PRP were 18.88% (27), PLT concentrate were 16.78%, exchange transfusion was 10.49% & whole blood 4.20 %.

Figure 3

Blood Transfusion Need



Ventilator mode preference according to ABGs & PEEP adjustment no had felt or need that had 2.1% (3), PC-CMV 15.4%(22), CPAP 9.1% (13), BiPAP 6.3%(9), SIMV 18.2% (26), concentrated oxygen trough nasal cannula 44.8 % (64) & from Ambu bag 4.2% (6).

Figure 4

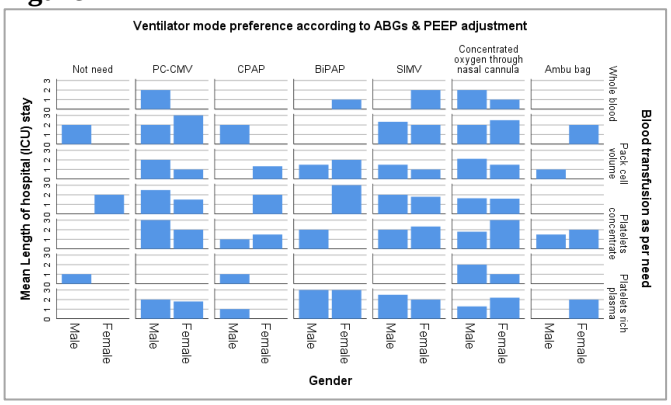
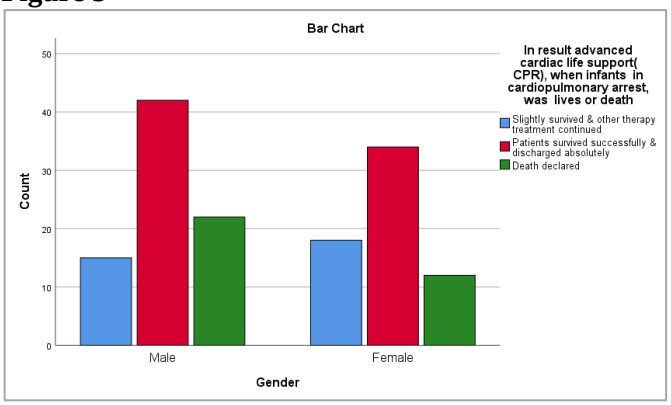


Figure 5



As a result, advanced cardiac life support (CPR), when infants in cardiopulmonary arrest, was lives or death Slightly survived & other therapy treatment continued 23%, Patients survived successfully & discharged were 53% and who infants death declared were 24%.

DISCUSSION

This research is of great importance to me because infants, being innocent and unable to express their pain, may suffer in ways that go unnoticed. My study aims to identify risk factors associated with acute respiratory distress syndrome (ARDS) in pediatric patients, a condition that presents significant morbidity, mortality, and financial burdens. Conducted at one of Lahore's largest hospitals, the study targeted a well-defined sample of young resident doctors interested in the socio-demographic aspects of ARDS. ARDS was first identified in 1967, with early studies describing acute hypoxemia in critically ill adults, later extending to children. The American-European Consensus Committee (AECC) and the 2012 Berlin definition further refined its classification, emphasizing the need for international collaboration in ARDS research, particularly between North America and Europe. Pediatric ARDS (PARDS) was formally defined in 2015 with specific diagnostic standards, such as the PF ratio and oxygenation index (OI), which are influenced by ventilator pressure settings(15,16). This is particularly relevant in resource-limited settings where optimizing treatment strategies is crucial. Identifying mortality risk factors remains essential, especially as viral infections like SARS, H5N1, and H1N1 influenza contribute significantly to ARDS prevalence in children(17).

The PRISM III score has demonstrated outstanding precision in predicting ARDS outcomes, helping physicians determine prognosis and allocate resources effectively. Clinical trials targeting RSV-induced ARDS could provide valuable insights into novel treatments, while stepwise recruitment maneuvers may enhance pulmonary mechanics in hemodynamically stable pediatric patients(18,19). Supportive therapies for ARDS, including surfactant administration and noninvasive ventilation techniques like nasal CPAP and NHFOV, have shown promise in improving respiratory function and reducing complications. In high-income countries, the Clinical Respiratory Score (CRS) has emerged as a potential screening tool for severe cases, while the Montreux criteria for neonatal ARDS align closely with broader ARDS definitions. Leading medical institutions, including Peking University, Harvard School of Public Health, and Beijing Friendship Hospital, have endorsed studies on mechanical ventilation strategies, which remain essential for ARDS management. Surfactant therapy, combined with bronchoalveolar lavage (BAL) using normal saline, has demonstrated a synergistic effect in clearing inhaled debris, recruiting collapsed lung regions, and maintaining surfactant levels(20-22).

Moreover, neonatal ARDS is often linked to premature birth, with conditions like maternal hypertension, diabetes, and cesarean deliveries increasing the risk of respiratory distress syndrome (RDS). Symptoms such as tachypnea, nasal flaring, and expiratory grunting are critical for early diagnosis, ideally within the first 48 hours of life. Treatment strategies, including early detection of pneumothorax via radiography, have improved survival rates, even among high-risk newborns. Additionally, phototherapy-induced endothelial progenitor cell (EPC) release has been associated with improved lung function and reduced CPAP dependency, potentially preventing bronchopulmonary dysplasia (BPD) (11). Despite these advancements, research gaps remain in the care of PARDS, necessitating further studies to refine ventilation techniques, optimize sedation protocols, and address disparities in access to critical care. Proportional ventilation modes offer a promising approach to lung and diaphragm protection, potentially reducing the incidence of critical illness neuropathy, delirium, and withdrawal syndromes. Socioeconomic factors, financial

limitations, and variations in case management continue to influence ARDS outcomes, highlighting the need for a more standardized global approach(22). Future research must focus on refining predictive models, advancing clinical trials, and implementing cost-effective interventions to improve the prognosis of pediatric ARDS patients worldwide.

CONCLUSION

The major risk factors for pediatric ARDS were preterm birth, with most patients requiring mechanical ventilation and oxygen support. Common diagnoses included sepsis, HIE II & III, pneumonia, metabolic fits, IDM, upper respiratory tract infections, early and late-onset sepsis, and meconium aspiration. Notably, surfactant administration was associated with a 24% mortality rate, highlighting its critical role in lung maturity and disease severity and is minimal evidence to support its use for severe paediatric ARDS in our pediatric intensive care units. Expert paediatricians, respiratory therapists, and their teams should all strongly agree that the main goals of treating ARDS remain to improve breathing techniques and address the underlying causes.

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