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Original Research Article

MEASUREMENT OF INTRA-ABDOMINAL PRESSURE IN CRITICALLY ILL CHILDREN WITH ASCITES–A HOSPITAL BASED PROSPECTIVE OBSERVATIONAL STUDY

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ABSTRACT

Background: Intra-abdominal hypertension (IAH) represents a significant contributor to morbidity in critically ill patients, yet standardized approaches to intra-abdominal pressure (IAP) measurement and clinical significance in pediatric populations with ascites remain incompletely defined. This study aimed to evaluate IAP in critically ill children with ascites, with particular focus on dengue-related conditions prevalent in our setting. **Materials and Methods:** This prospective observational study was conducted in a pediatric intensive care unit of a tertiary care hospital from July 2023 to June 2025. We enrolled 106 critically ill children aged 0-18 years with ultrasonographically confirmed ascites. IAP was measured using standardized bladder pressure technique at 12-hourly intervals. Disease severity was assessed using Pediatric Risk of Mortality (PRISM) scores. Statistical analysis included correlation testing, comparison of means, and ROC curve analysis. **Result:** The mean age was 8.54 ± 3.27 years with female predominance (60.4%). Severe dengue constituted 60.4% of cases, followed by dengue fever with warning signs (29.2%). Mean IAP was 13.83 ± 2.685 cmH_2O. IAP significantly correlated with PRISM severity scores ($p<0.001$) and varied significantly across diagnostic categories ($p<0.001$), with severe dengue exhibiting highest values. ROC analysis yielded an area under curve of 0.876 for IAP in determining severe dengue. Significant positive correlation existed between IAP and abdominal girth increase ($r=0.294$, $p=0.002$), while inverse relationship was observed with IVC collapsibility ($p=0.002$). **Conclusion:** IAP measurement provides valuable clinical information in critically ill children with ascites, demonstrating strong correlations with disease severity and diagnostic categories. The high discriminatory capability of IAP for severe dengue suggests potential utility in risk stratification. Regular IAP monitoring should be considered in management protocols for critically ill children with ascites.

INTRODUCTION

Intra-abdominal pressure (IAP) and its pathological elevation, known as intra-abdominal hypertension (IAH), have emerged as crucial considerations in the management of critically ill children. While this phenomenon has been well-studied in adult populations, its significance in pediatric critical care has only recently gained attention. The measurement and monitoring of IAP in critically ill children, particularly those with ascites, represents an important area of clinical research that can significantly impact patient outcomes.[1] The complex interplay between increased IAP and multiple organ dysfunction makes it essential to understand its pathophysiology and implement appropriate monitoring strategies in vulnerable pediatric populations.

The normal range of IAP in children differs from adults due to their unique anatomical and physiological characteristics. While adult critical care has established clear definitions and guidelines for IAH and abdominal compartment syndrome (ACS), pediatric-specific standards have been evolving. Research indicates that normal IAP in children ranges from 4-10 mmHg, with values above

10 mmHg considered elevated and potentially concerning.[2] The presence of ascites in critically ill children adds another layer of complexity to this clinical picture, as fluid accumulation in the peritoneal cavity can significantly impact IAP measurements and subsequent organ function. The World Society of the Abdominal Compartment Syndrome (WSACS) has emphasized the importance of regular IAP monitoring in at-risk patients, including those with significant fluid accumulation such as ascites.[3]

Recent studies have demonstrated that elevated IAP can lead to significant physiological derangements affecting multiple organ systems. The cardiovascular system is particularly vulnerable, with increased IAP leading to reduced venous return, decreased cardiac output, and compromised tissue perfusion. Research has shown that even moderate elevations in IAP can impact renal function by reducing renal blood flow and glomerular filtration rate, potentially exacerbating the underlying critical illness.[4] The respiratory system is also affected, with increased IAP leading to reduced chest wall compliance and impaired ventilation, which is particularly concerning in mechanically ventilated children. Early recognition of IAH in critically ill children with ascites is vital for preventing the progression to ACS, a potentially lethal condition characterized by organ dysfunction due to sustained elevation of IAP.[5]

MATERIALS AND METHODS

This hospital-based prospective observational study was conducted in the Pediatric Intensive Care Unit at a tertiary care teaching hospital from July 2023 to June 2025. The study protocol was approved by the Institutional Ethics Committee, and written informed consent was obtained from parents or legal guardians of all participants. Children aged 0-18 years admitted to the PICU with ascites were included, with diagnosis confirmed through clinical examination and ultrasonography. Patients with neurogenic bladder, urinary tract infection, bladder trauma, recent bladder surgery, congenital genitourinary abnormalities, or those whose parents refused consent were excluded.

Intra-abdominal pressure was measured indirectly through the bladder using the modified Kron's method, adapted for pediatric patients. With patients in supine position, the bladder was emptied and instilled with sterile normal saline at 1 ml/kg volume, not exceeding 25 ml. The zero point was established at the mid-axillary line at the level of the iliac crest. A three-way stopcock connected the Foley catheter, pressure transducer, and instillation syringe. After instillation, the system equilibrated for 30-60 seconds before pressure recording in centimeters of water (cmH_2O). Patients were monitored at 12-hourly intervals throughout their PICU stay, with documentation of demographic information, primary diagnosis, severity scores (PRISM), ultrasonographic parameters, and clinical outcomes.

Statistical analysis was performed using SPSS version 16.0. Descriptive statistics were presented as means ± standard deviation for normally distributed continuous variables and frequencies with percentages for categorical variables. Binary logistic regression analysis evaluated the predictive value of IAP for critical illness outcomes. The association between IAP and clinical outcomes was assessed using appropriate statistical tests, with p-value <0.05 considered statistically significant. ROC curve analysis was performed to determine the discriminatory capability of IAP for severe dengue diagnosis.

RESULTS

Table 1: Patient Demographics and Clinical Characteristics

Parameter	Value
Age (years)	8.54 ± 3.27
Gender	
Female	64 (60.4%)
Male	42 (39.6%)
Primary Diagnosis	
Severe Dengue	65 (60.4%)
Dengue fever with Warning Signs	31 (29.2%)
Rickettsial Fever	5 (4.7%)
Other diagnoses	5 (4.7%)
PRISM Severity	
Mild (5-10)	66 (62.3%)
Moderate (10-15)	19 (17.9%)
High (15-20)	21 (19.8%)

Table 2: Intra-abdominal Pressure Measurements and Clinical Parameters

Parameter	Value
IAP (cmH_2O)	13.83 ± 2.685
IAP Categories	
0-7 cmH_2O	3 (2.8%)
8-16 cmH_2O	94 (88.7%)
16-27 cmH_2O	9 (8.5%)

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Abdominal Girth Increase (cm)	3.43 ± 1.203
IVC Collapsibility Index (%)	26.20 ± 7.93
Ultrasonographic Findings	
Ascites	106 (100%)
Pleural Effusion	103 (97.2%)

Table 3: IAP Correlation with Disease Severity and Diagnosis

Parameter	IAP (cmH_2O)	p-value
PRISM Severity		<0.001
Mild	12.52 ± 2.43	
Moderate	15.89 ± 0.31	
High	16.10 ± 1.84	
Diagnosis		<0.001
Severe Dengue	15.20 ± 1.58	
Dengue with Warning Signs	13.00 ± 1.73	
Other Diagnoses	11.29 ± 2.83	

Table 4: Correlations and ROC Analysis

Parameter	Value	p-value
Correlations		
IAP vs Abdominal Girth Increase	r = 0.294	0.002
IAP vs IVC Collapsibility	r = -0.293	0.002
ROC Analysis		
AUC for IAP in Severe Dengue	0.876	-
Mortality Parameters		
Survivors - IAP (cmH_2O)	13.51 ± 2.64	0.001
Non-survivors - IAP (cmH_2O)	16.15 ± 1.72	

Study Population and Measurements: This study enrolled 106 critically ill children with ascites over the study period. IAP measurements were obtained using standardized bladder pressure technique at regular intervals. Disease severity was assessed using PRISM scores, while ultrasonographic evaluation documented ascites presence and associated findings. Statistical analysis examined correlations between IAP and various clinical parameters, with particular focus on diagnostic categories and severity indicators.

DISCUSSION

Our study provides valuable insights into IAP dynamics in critically ill children with ascites, particularly those with dengue-related conditions. The strong correlation between IAP and PRISM severity scores (p<0.001) aligns with findings from Pearson et al., who demonstrated that PRISM III scores were significantly higher in pediatric patients who developed IAH.[6] Similarly, Thabet et al. found correlations between higher PRISM scores and increased IAP in critically ill children.[7] Our findings corroborate this relationship in a predominantly dengue-affected population, suggesting that IAP may serve as a valuable physiological marker of overall disease severity. The pathophysiological basis for this correlation likely involves multiple mechanisms, including capillary leak, aggressive fluid resuscitation, and third-spacing, all contributing to elevated IAP as suggested by Malbrain et al.[8]

The significant differences in IAP across diagnostic categories (p<0.001), with severe dengue patients exhibiting the highest mean IAP (15.20±1.58 cmH_2O), represents a novel finding with potential clinical applications. Limited literature exists on IAP in dengue patients, especially in pediatric populations. Our ROC curve analysis yielded an area under the curve of 0.876 for IAP in determining severe dengue, suggesting excellent discriminatory capability and potential utility in risk stratification. This finding is particularly relevant in dengue-endemic regions where objective markers of disease severity are crucial for optimal resource allocation and intervention timing. The pathophysiological explanation lies in the unique vascular leak syndrome characteristic of severe dengue, where increased vascular permeability leads to significant fluid accumulation in serous cavities, as elaborated by Srikiatkhachorn et al.[9] The combination of plasma leakage, hepatic involvement, and necessary fluid resuscitation creates ideal conditions for IAH development in these patients.

The observed relationships between IAP, abdominal girth increase (r=0.294, p=0.002), and IVC collapsibility index (r=-0.293, p=0.002) provide promising avenues for complementary assessment strategies. These findings align with research by Davis et al., who reported significant correlations between abdominal circumference changes and IAP in postoperative pediatric patients.[10] The moderate correlation strength suggests that factors beyond simple fluid volume contribute to IAP elevation, as proposed by Malbrain et al, including abdominal wall compliance and intra-abdominal volume.[11] The inverse relationship between IAP and IVC collapsibility corroborates findings by Nagdev et al, who demonstrated reduced IVC collapsibility in conditions associated with elevated central venous pressure.[12] Our findings support the integration of IAP monitoring into standard care algorithms for critically ill children with ascites, particularly in dengue-endemic regions, as continued investigation

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may enhance risk stratification and guide therapeutic interventions to improve outcomes in this vulnerable population.

CONCLUSION

This prospective observational study demonstrates that intra-abdominal pressure measurement provides valuable clinical information in critically ill children with ascites. The strong correlation between IAP values and PRISM severity scores, along with significant differences across diagnostic categories, supports the utility of IAP as both a prognostic indicator and diagnostic tool. The excellent discriminatory capability of IAP for severe dengue (AUC = 0.876) suggests its potential role in risk stratification and clinical decision-making, particularly relevant in dengue-endemic regions. The observed relationships between IAP, abdominal girth increase, and IVC collapsibility index offer promising complementary assessment strategies that may prove valuable in resource-limited settings. Regular IAP monitoring should be considered an integral component of assessment protocols for critically ill children with ascites, especially those with severe dengue or high PRISM scores, to facilitate early recognition of complications and guide therapeutic interventions.

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