

## Intra-Abdominal Pressure and Renal Functions in Critically Ill Children

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### Abstract

### Original Research Article

**Background:** Intra-abdominal pressure is neglected entity in clinical practice. Intra abdominal hypertension affects various systems of the body. Objective of this study was to evaluate intra abdominal pressure and renal functions in critically ill children. **Methods:** This prospective study was carried out in the months of October and November 2019. Consecutive 30 critically ill children admitted in pediatric intensive care unit who required urinary catheterization were included in our study. Intra abdominal pressure was measured by intra vesical technique and renal functions were evaluated by using pediatric risk, injury, failure, loss of function and end stage kidney disease classification (pRIFLE classification). SPSS version 25 was used for statistical analysis. **Results:** Nine (30%) critically ill children had raised intra abdominal pressure. None of the patient had abdominal compartment syndrome. Increased intra abdominal pressure was significantly associated with worsening of pRIFLE class. **Conclusion:** Intra abdominal pressure and renal functions play important role in the management of critically ill children.

**Keywords:** critically ill children, intra abdominal pressure, renal functions, pRIFLE.

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## INTRODUCTION

Importance of evaluating the intra abdominal pressure (IAP) and intra abdominal hypertension (IAH) in critically ill patients has been emphasized in recent literature [1]. Intra abdominal pressure is constant pressure inside the abdominal cavity. Rise in the intra abdominal pressure results in intra-abdominal hypertension [2]. Intra abdominal hypertension is IAP more than 12 mmHg. IAP more than 20 mmHg is abdominal compartment syndrome and it leads to end organ dysfunction which results in organ failure [3].

Intra abdominal hypertension is prevalent in critically ill patients. Intra abdominal hypertension hampers functions of abdominal organs, cardiovascular system, pulmonary system, renal functions and central nervous system. Higher risk for death is associated with intra-abdominal hypertension [4-6]. Previous literature suggests that intra abdominal hypertension results in renal impairment by direct or indirect mechanisms. It is crucial to understand patterns of intra abdominal pressure and renal dysfunction in order to identify the risk factors and the need of treatment for intra abdominal hypertension and renal dysfunction [4-7].

Data regarding intra abdominal pressure and renal dysfunction in pediatric age group is scarce [8]. Hence we carried out this study to evaluate intra

abdominal pressure and renal functions in critically ill children.

## AIMS & OBJECTIVES

To study intra-abdominal pressure and renal functions in critically ill children

## METHODOLOGY

This prospective study was carried out in pediatric intensive care unit (PICU) at Smt. Kashibai Navale Medical College, Pune in October and November 2019. Ethical committee had approved study protocol. Thirty consecutive children of age between 1 to 12 years admitted in PICU who had urinary catheterization were enrolled in our study. Patients were included in study after obtaining written Informed consent from parents of children. Patients with primary diagnosis of renal disorders were excluded from our study. Data regarding age, gender, diagnosis was noted.

Intra abdominal pressure was measured by intravesical pressure measuring technique [9]. After participant lied down in supine position, bladder was emptied. Then bladder was filled with 1ml/kg of normal saline through Foley's catheter. After one minute, height of water column was measured considering

pubic symphysis as a reference point. This value was converted into mmHg after dividing it by 1.36.

Pediatric age adapted Sequential organ failure Assessment (SOFA) score was evaluated for each participant [10, 11]. Acute renal dysfunction was evaluated by pRIFLE classification based on urine output. It grades acute renal dysfunction in risk, injury, failure, loss of function and end stage kidney disease [12]. Statistical analysis was done by SPSS software version 25.

## RESULTS

Consecutive 30 patients admitted in the pediatric intensive care unit were enrolled in our study.

Average age of study participants was  $6.50 \pm 3.003$  years. Sixteen patients were male and 14 patients were female [Table 1].

Twenty one (70%) patients had normal intra abdominal pressure which is intra abdominal pressure less than 12 mmHg and 9 patients (30%) had increased intra abdominal pressure i.e. 12 to 20 mmHg. None of the patient had abdominal compartment syndrome [Table 2].

Age adapted SOFA score was higher in increased IAP patients. However it did not reach statistical significance. [Table 3] Renal dysfunction was significantly associated with increased IAP [Table 4].

**Table-1: Clinical characteristics of study participants**

Characteristic		Mean/Frequency
Age in years		6.50 ± 3.003
Gender	Males	16
	Female	14
Primary diagnosis	Cardiac diseases	7
	Pulmonary diseases	5
	Neurological diseases	7
	Abdominal diseases	4
	Sepsis	7

**Table-2: Intra-abdominal pressure in study participants**

Characteristic	Frequency
Normal Intra abdominal pressure (IAP < 12 mm Hg)	21 (70%)
Increased intra abdominal pressure (IAP 12 to 20 mm Hg)	9 (30%)
Abdominal compartment syndrome (IAP < 20 mm Hg)	0 (0%)

**Table-3: Association of intra abdominal pressure with age adopted SOFA**

Characteristic	Mean	p value
Normal IAP (IAP < 12 mm Hg)	2.14 ± 2.920	Not significant
Increased IAP (IAP 12 to 20 mm Hg)	3.89 ± 3.018	

Mann Whitney U test was used.

**Table-4: Relationship of pRIFLE class with intra abdominal pressure**

pRIFLE classification	Normal IAP	Increased IAP	p value
No renal dysfunction	15	2	< 0.05
Risk	3	3	
Injury	3	3	
Failure	0	1	
Loss	0	0	
End stage renal failure	0	0	

Spearman rank coefficient was used to assess association between IAP and pRIFLE classification

## DISCUSSION

Recent literature has highlighted the importance of intra abdominal pressure. Intra vesical route is commonly used for assessment of intra abdominal pressure. In our study we found that 30 % of critically ill children have increased intra abdominal pressure. Singhal J *et al.* reported 3.75 % prevalence of increased intra abdominal pressure in children admitted to the pediatric intensive care unit [9]. Prevalence of

increased intra abdominal pressure is high in our study which can be attributed to clustering of more critical patients and differences in primary disease of study participants. Similar to our study Singhal J *et al.* did not report abdominal compartment syndrome in any of their study participants. They considered intra abdominal pressure less than 12 mm Hg as normal intra abdominal pressure and intra abdominal pressure from 12 to 15 mm Hg as grade I intra abdominal pressure grade I intra

abdominal hypertension. This is as per World Society of the Abdominal Compartment Syndrome grading of intra abdominal pressure and we have utilized this grading system's cutoff values in our study [13]. We set IAP value more than 20 mmHg as abdominal compartment syndrome and value between 12 to 20 mmHg as increased intra abdominal pressure. However Ejike JC *et al.* suggested that upper normal cutoff value for intra abdominal pressure should be 10 mm Hg in critically ill children since they are at higher risk of developing abdominal compartment syndrome compared with normal individuals [14]. Prasad GR *et al.* studied intra abdominal pressure in post operative pediatric patients. They reported prevalence of abdominal compartment syndrome in 23.9% of older children and 11.3% of infants [15].

Our study noted significant association of renal dysfunction and increasing intra abdominal pressure. Previous literature has discussed pathophysiology of renal dysfunction associated with increased intra-abdominal pressure [16]. Cullen, David J., *et al.* reported that decreased urine output reversed within 15 minutes after surgical decompression in critically ill patients with increased intra abdominal pressure. [17] Doty, James M., *et al.* studied the effects of changes in renal parenchymal pressure in swines. Glomerular filtration rate and renal artery blood flow index did not change significantly after increasing renal parenchymal pressure [18]. One of their previous studies reported negative relationship between renal venous pressure with glomerular filtration rate and renal artery blood flow index in swines [19]. These findings may have implications in pathophysiology of renal dysfunction in patients with intra abdominal hypertension suggesting that renal dysfunction may be due to increased pressure on renal vein rather than increased renal parenchymal pressure.

Our study noted that that age adapted SOFA score was worse in increased IAP patients; however it did not reach statistical significance. Prasad GR *et al.* noted significant association of increased intra abdominal pressure with worsening of simplified sequential organ assessment score [15].

Measuring intra abdominal pressure is not routine protocol in pediatric intensive care unit. Increased intra abdominal pressure is associated with higher mortality. Large magnitude of patients admitted in intensive care units suffer from intra abdominal hypertension. If untreated it has deleterious effects on various organs resulting in organ failure [20, 21]. Children with abdominal compartment syndrome have prevalence of ascites, atelectasis of basal lungs, compression of the inferior vena cava, and abnormal bowel wall enhancement in radiological imaging [22]. Intra-abdominal pressure should be assessed in critically ill children admitted in intensive care unit on admission and after regular intervals. It will be helpful

in decreasing morbidity and mortality associated with intra abdominal hypertension and abdominal compartment syndrome.

Small sample size is limitation of our study. Large randomized controlled trials are needed to tackle renal dysfunction and intra abdominal pressure in critically ill children.

## CONCLUSION

Increased intra-abdominal pressure has deleterious effects on various organs. Increased intra abdominal pressure is prevalent in critically ill children and it is associated with renal dysfunction. We suggest that evaluation of intra abdominal pressure should be incorporated into routine assessment of critically ill children.

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