Journal of Cardiovascular Disease Research

ISSN: 0975-3583,0976-2833 VOL13, ISSUE 05, 2022

"INTRA-ABDOMINAL PRESSURE MONITORING IN CRITICALLY ILL PATIENTS ADMITTED IN INTENSIVE CARE UNIT (ICU) AS A PREDICTOR OF ACUTE KIDNEY INJURY"

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Abstract

Background: To find relationship between Intra-abdominal hypertension (IAH) and acute kidney injury in critically ill patients. To evaluate predictive factors for Intra-abdominal hypertension. To calculate APACHE 2 Score at the time of admission and SOFA score, RIFLE criteria calculated daily and risk of developing AKI and multiorgan dysfunction is assessed. **Material and Methods:** ICU patients admitted in KIMS hospital Bangalore falling under inclusion criteria will be considered for the study, with their admission APACHE2 score. Intra-abdominal pressure was measured at 24 hr interval for first 5 days via foleys bladder catheter, as recommended by WSACS. Patients will be followed up with RIFLE and SOFA scoring computed daily from the day of admission. **Results:** In our study, about 50 patients were considered. Prevalence of IAH was 68%. About 34% of the patients in the study had grade I IAH, 32% of the patients had grade 2 and 2% of the patients had grade 3 IAH.IAH was predominantly seen in males. About 97.1 % of the patients with raised intra-abdominal pressure had sepsis. In our study, correlation of blood urea level and serum creatinine levels with elevated IAP was found to be statistically significant. In our study, the mean urine output is significantly lesser in raised IAP group than in normal IAP group and. The correlation between SOFA score and intra-abdominal hypertension was statistically significant. The mean APACHE 2 score was significantly higher in raised IAP group as compared to normal IAP group, and the correlation between the APACHE 2 score and raised IAP was statistically significant. Among the patients with raised IAP, about 41.2 % of the patients had APACHE 2 score between 20-24.About 23.5% of the patients with elevated Intra-abdominal pressure died. **Conclusion:** Positive correlation was established between elevated IAP and acute kidney injury as defined by RIFLE criteria, with significantly lesser mean urine output in raised IAP group. It was found that with increasing grade of intraabdominal hypertension patients were found to have, higher SOFA score, which was

ISSN: 0975-3583,0976-2833 VOL13, ISSUE 05, 2022

statistically significant. The mean APACHE 2 score was found to be significantly higher in elevated IAP group as compared to normal IAP group, and the correlation between the APACHE 2 score and raised IAP was found to be statistically significant .Among the patients with raised IAP, about 41.2 % of the patients had APACHE 2 score between 20-24. About 23.5% of patients with elevated Intra-abdominal pressure died. Mortality rate was s higher in elevated IAP group, especially in grade 2 IAH.

Keywords: Acute kidney injury, lntra abdominal pressure, Intra-abdominal hypertension.

Introduction

Acute kidney injury(AKI) is defined,[1] by rise in serum creatinine from baseline by atleast 0.3mg/dl within 48hr or by atleast 50% elevation from the baseline within duration of 1 week, or decrease in urine output to less than 0.5ml/kg per hour for more than 6 hours. AKI is known to complicate up to 30% of ICU admission. AKI is associated with increased mortality in hospitalized individuals, especially those admitted to the Intensive care unit (ICU) where in-hospital mortality may be more than 50%.[1] AKI can worsen the existing renal disease; also can increase the risk of development of chronic kidney disease (CKD). Patients recovering from an event of severe AKI requiring dialysis will be at increased risk for the development of dialysis-requiring end-stage kidney disease at later stage in life. Raised intra-abdominal pressure is an important possible cause of acute renal failure in critically ill patients and screening may benefit those at increased risk. Normal intra-abdominal pressure is considered to be 5 to 7 mm Hg for a relaxed individual of average body builds lying in a supine position.3 abnormally increased intra-abdominal pressures diminish the blood flow to abdominal organs, and kidneys are more sensitive to raised intra-abdominal pressure causing renal hypoperfusion and acute kidney injury (AKI).

Objectives

1. To find relationship between Intra-abdominal hypertension(IAH) and acute kidney injury in critically ill patients
2. To evaluate predictive factors for Intra-abdominal hypertension.
3. To calculate APACHE 2 score at the time of admission
4. To calculate correlation between Intra-abdominal pressure and RIFLE criteria
5. SOFA score is also calculated daily and risk of developing AKI and multi- organ dysfunction will be determined

Material and Methods

Source of data: All critically ill patients admitted in ICU of General medicine Department, in KIMS hospital Bangalore ,will be taken up for the study after considering the inclusion and exclusion criteria.

Methods of Collection of Data:

Study design: Observational study

Study period: 1.5 years.

Place of study: Kempegowda Institute of Medical Science and Research Centre, Bangalore.

Statistical analysis: Statistical Package for Social Sciences [SPSS] for Windows Version 22.0 Released 2013. Armonk, NY: IBM Corp., was used to perform statistical analyses.

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Descriptive Statistics: Descriptive analysis of all the explanatory and outcome parameters was done using frequency and proportions for categorical variables, whereas in Mean & SD for continuous variables.

The total sample size N= 50

Total: 50 patients.

Sampling method: Purposive sampling:

Inclusion Criteria:

1. Age >18 yrs.
2. Admitted for >24 hrs in Intensive care unit (ICU) m KIMS hospital bangalore will be enrolled.
3. Patient willing to give informed consent.

Exclusion Criteria:

1. Patient not willing to give informed consent.
2. Age<l 8yrs.
3. Those admitted for <24hrs.
4. Contraindication to intravesical pressure measurements (pelvic fractures with associated bladder injuries, hematuria, neurogenic bladder).
5. Pregnancy, intraabdominal tumors.
6. Chronic renal failure requiring hemodialysis

Methodology:

- After obtaining approval and clearance from the institutional ethics committee, the patients fulfilling the inclusion criteria will be enrolled for the study after obtaining their informed consent. Baseline data regarding age, sex and detailed medical history of patients will be collected, to know the clinical profile of patients, included in this study.
- Measurements were performed on admission and atleast every 24hr during first days of ICU stay. Admission APACHE 2 score calculated. Rifleand Sofa Score computed daily.

Assessment tools:

1. Intra-abdominal pressure scale (world society of abdominal compartment syndrome grading of intraabdominal pressure).
2. Sofa score (Sequential organ failure assessment score).
3. APACHE 2 score (Acute Physiology and Chronic Health Evaluation 2).
4. RIFLE criteria (Risk, Injury, Failure, Loss of renal function and End stage renal disease).

Results

Table 1: Age and Gender Distribution

Age and Gender distribution among study patients			
Variable	**Category**	**n**	**%**
Age	20-40years	9	18%
	41-60years	21	42%
	61-80years	18	36%
	>80years	2	4%
Sex	Males	33	66%
	Females	17	34%

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In our study, total 50 patients were included, with predominate age group being between 41-60 yrs of age,(about 42% patients belonged to this age group)followed by 36% of the patients in 61-80 years of age group, 18% of the patients belonged to 20-40 years of age group and 4% of patients belonged to >80 yrs of age group as shown in table 4.66% of the patients included were males and 34% of patients were female as shown in [Table 1].

Table2: Distribution of various clinical symptoms among study patients

Variable	**Category**	**n**	**%**
Clinical Symptoms	Fever	14	28%
	Breathlessness	14	28%
	Cough	9	18%
	Swelling & Numbness in Lower Limbs	5	10%
	Vomiting	4	8%
	Pain Abdomen	4	8%
	Altered Sensorium	4	8%
	Burning Micturition	4	8%
	Low Urine Output	3	6%
	Loose Stools	**2**	4%
	Lower Limb Weakness	2	4%
	Slurred Speech	2	4%
	Uncontrolled DM	2	4%
	Altered sleep cycle	1	2%
	OP Poison	1	2%

In our study, about 28% of the patients had fever as the predominant symptom, 28% of the patients had breathlessness as main symptom, 18% had cough, 10% had swelling and numbness in lower limbs, 8% of the patients had vomiting, 8% of the patients had pain abdomen, 8% had altered sensorium, 8% had burning micturition, 6% had low urine output, 4% had loose stools, 4% had lower limb weakness and slurred speech, 4% had uncontrolled sugars, 2% had come with altered sleep cycle and 2% presented with history of consumption of OP poison as shown in [Table 2].

Table 3: Distribution of presence of different co-morbidity conditions among study patients

Variable	**Category**	**n**	**%**
Co-Morbidity	DM	33	66%
	HTN	24	48%
	IHD	8	16%
	CLD	2	4%
	CRD	7	14%
	COPD/Asthma	6	12%

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Comorbidities of patients involved in our study are depicted in [Table 3]. About 66% of the patients involved in the study had diabetes mellitus, 48% of the patients had hypertension, 16% of the patients had Ischemic heart disease (IHD), 4% had chronic parenchymal liver disease (CLD), 14% of the patients had chronic renal disease (CRD), and 12% of the patients had chronic obstructive pulmonary disease (COPD)/Asthma.

Table 4: Distribution of risk factors for acute kidney injury (AKI) in study patients

Variable	Category	n	%
Causes of AKI	Pneumonia with Sepsis	19	38%
	Urosepsis	9	18%
	Cardio/Hepatorenal causes	5	10%
	Gangrene with Sepsis	4	8%
	Pyelonephritis with Sepsis	3	6%
	Acute GE with Sepsis	2	4%
	Pancreatitis with Sepsis	2	4%
	Necrotising Fasicitis & Sepsis	2	4%
	Meningoencephalitis & Sepsis	2	4%
	Cellulitis/Puerperal sepsis	2	4%

Causes of acute kidney injury in these study patients are mentioned in [Table 4]. About 38% of the patients involved in the study had pneumonia with sepsis as a causative factor for AKI. About 18% of the patients had urosepsis with AKI. About 10% of the patients had cardio-renal and hepatorenal syndrome as a causative factor for AKI. About 8% of the patients had gangrene with sepsis and AKI, 6% of the patients had pyelonephritis with sepsis and AKI, 4% had acute gastro enteritis (AGE) with sepsis and AKI, 4% of the patients had pancreatitis with sepsis and AKI, 4% of the patients had necrotizing fascitis with sepsis and AKI, 4% had meningo-enchephalitis and sepsis with AKI, 4%of the patients had cellulitis and puerperal sepsis.

Table 5: Comparison of Intra-abdominal pressure among study patients from Day 1 to 3 using Cochran's Q Test

Time	Category	Day1		Day2		Day3		P-Value
		n	%	n	%	n	%	
Intra- Abdominal Pressure	Raised	40	80%	39	78%	32	64%	0.02*
	Normal	10	20%	11	22%	18	36%	

50 patients were included in our study, of which 40 patients had IAH on day 1.While comparing patients with elevated intra-abdominal pressure and day I and day 3,it was found that one day I about 80% of the patients had raised intra-abdominal pressure(IAP),and following adequate treatment of etiological factors for raising intra-abdominal pressure, by day 3 patients with elevated intra-abdominal pressure had decreased to 64%.There was significant decrease in IAP from day I to day 3,and the decrease in IAP from day 2 to day 3 was statistically significant with p value of 0.04 as shown in the [Table 5].

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Table 6: Multiple comparison of Intra-abdominal pressure from Day 1 to Day using McNemar's Test

Time	D1vsD2	DlvsD3	D2vsD3
P-Value	1.00	0.06	0.04*

Table 7: Distribution of different grades of Intra-Abdominal Pressure among study patients

Variable	Category	N	%
Intra-Abdominal Pressure	Normal[<12mmHg]	16	32%
	Grade1[12-15mmHg]	17	34%
	Grade2[16- 20mmHg]	16	32%
	Grade3[21-25mm Hg]	1	2%

There were patients belonging to different grades of intra —abdominal hypertension in our study. Average of intra-abdominal pressure readings, taken over 5 days for each patient, was taken. It was found that 32% of patients' average IAP reading was within normal, i.e<12mmHg.34% of the patients in the study had grade 1 abdominal hypertension, 32% of patients in the study had grade 2 abdominal hypertension, 2% of the patients had grade 3 abdominal hypertension as shown in [Table 7].

Table 8: Prevalence of Raised Intra-Abdominal Pressure among study patients

Variable	Category	N	%
Intra-Abdominal Pressure	Raised	34	68%
	Normal	16	32%

Prevalence of intra-abdominal hypertension in our study was 68% as shown in the [Table 8], about 38% of the patients had normal IAP (the average of lAP readings).

Table 9: Gender wise comparison of Intra-Abdominal Pressure among study patients using Chi Square Test

Variable	Category	Raised		Normal		^{2}Value	P-Value
		n	%	n	%		
Gender	Males	26	76.5%	7	43.8%	5.191	0.02*
	Females	8	23.5%	9	56.2%		

In our study it was seen that, amongst the patients with raised IAP, 76.5% of the patients were males and the rest 23.5% were constituted by females and it is statistically significant with p value of 0.02 as shown in [Table 9].

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Table 10: Comparison of Intra-Abdominal Pressure status based on the Co-morbidity condition of patients using Chi Square Test

Comorbidity	Category	Raised		Normal		^{2}Value	P-Value
		n	%	n	%		
DM	Yes	19	55.9%	14	87.5%		
	No	15	44.1%	2	12.5%	4.847	0.03*
HTN	Yes	16	47.1%	8	50.0%		
	No	18	52.9%	8	50.0%	0.038	0.85
IHD	Yes	6	17.6%	2	12.5%		
	No	28	82.4%	14	87.5%	0.214	0.64
CLD	Yes	2	5.9%	0	0.0%		
	No	32	94.1%	16	100.0%	0.980	0.32
CRD	Yes	6	17.6%	1	6.3%		
	No	28	82.4%	15	93.8%	1.174	0.28
COPD/Asthma	Yes	4	11.8%	2	12.5%		
	No	30	88.2%	14	87.5%	0.006	0.94

In our study we did comparison of IAP amongst the patients with various comorbidities as shown in [Table 10], and it was found that about 55.9% of the people with raised IAP had diabetes mellitus and 44.1% of the patients did not have diabetes mellitus. 47.1% of the patients with raised IAP had hypertension.17.6% of the patients with raised IAP had IHD.5.9% of the patients had CLD.

17.6% of the patients had Chronic renal disease.11.8% of the patients had COPD/Asthma. Hence in our study, it was seen that raised intra-abdominal pressure was seen more m diabetics when compared to non-diabetics and this correlation was found to be statistically significant with p value of 0.03. Other commodities however did not show any statistically significant correlation to raise in intra-abdominal pressure, in our study.

Table 11: Comparison of Intra-Abdominal Pressure status based on the Risk factors of AKI among study patients using Chi Square Test

Variable	Category	Raised		Normal		^{2}Value	P-Value
		n	%	n	%		
Risk	Acute GE with Sepsis	2	5.9%	0	0.0%		
Factors of	Pneumonia with Sepsis	11	32.4%	8	50.0%		
AKI	Pancreatitis with Sepsis	2	5.9%	0	0.0%		
	Necrotising Fasicitis &Sepsis	2	5.9%	0	0.0%		
	Pyelonephritis with Sepsis	3	8.8%	0	0.0%		
	Urosepsis	6	17.6%	3	18.8%	12.401	0.19
	Meningoencephalitis & Sepsis	2	5.9%	0	0.0%		
	GangrenewithSepsis	3	8.8%	1	6.3%		
	Cellulitis*I*Puerperalsepsis	2	5.9%	0	0.0%		
	Cardio/Hepatorenalcauses	1	2.9%	4	25.0%		

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Many varied risk factors for AKI were present in the study, but however the distribution of risk factors in the two study group(that is one with raised intra-abdominal pressure and the other with normal IAP), were almost the same with no statisticaly significant correlation between causative factor for AKI and raised intra-abdominal pressure as shown in [Table 11].

Table 12: Correlation between Rifle's Score and Intra-abdominal pressure status at different time intervals using Chi Square Test

Time	Rifle's Score	IAPR aised		IAP Normal		P-Value
		n	%	n	%	
Day1	No Risk	1	2.5%	4	40.0%	0.001*
	Injury	17	42.5%	2	20.0%	
	Risk	6	15.0%	3	30.0%	
	Failure	16	40.0%	1	10.0%	
Day2	No Risk	0	0.0%	1	9.1%	0.02*
	Injury	15	38.5%	2	18.2%	
	Risk	8	20.5%	6	54.5%	
	Failure	16	41.0%	2	18.2%	
Day3	No Risk	1	3.1%	2	11.1%	0.02*
	Injury	10	31.3%	7	38.9%	
	Risk	6	18.8%	8	44.4%	
	Failure	15	46.9%	1	5.6%	

Intra- abdominal pressure monitoring was done daily with calculation of RIFLE criteria daily as an indicator of severity of acute kidney injury. In our study it was found that on day 1, about 42.5% of the patients with raised intra-abdominal pressure(IAP) had acute kidney injury as per RIFLE scoring and about 40% of the patients had acute kidney failure. About 15% of the patients with elevated IAP had risk of developing acute kidney injury as per RIFLE criteria, by day 3, 31.3% of the patients with elevated IAP had acute kidney injury, and 46.9% of patients with elevated IAP had acute renal failure, and 18.8% of the patients were at risk of developing AKI. Hence patients with elevated intra-abdominal pressure, had more incidence of acute kidney injury and acute renal failure (defined as per RIFLE criteria) when compared to patients with normal IAP, and this c01Telation was found to be statistically significant from day 1 to day 3 of measurements, with p value of 0.001 on day 1; 0.02 on day 2 and 0.02 on day 3 as shown in [Table 12].

Table 13: Comparison of mean Hb& Total count based on Intra-Abdominal Pressure status among study patients using Mann Whitney Test

Parameter	IAP	N	Mean	SD	Mean Diff	P-Value
Hb	Raised	34	10.54	3.18	-0.07	0.68
	Normal	16	10.61	2.11		
TC	Raised	34	18716.76	10345.54	4454.88	0.10
	Normal	16	14261.88	6736.27		

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Routine blood investigations were done in the study, mean hemoglobin (Hb)was 10.54 in a group with raised intra-abdominal pressure, and was 10.61 in group with normal IAP and there was no statistically significant correlation between hemoglobin values and elevated !AP. Mean WBC count in group with elevated IAP is 18716.76; and is 14261.88 in group with normal IAP and however there is no statistically significant correlation between the WBC values and elevated IAP as shown in [Table 13].

Table 14: Comparison of mean values of different study parameters based on Intra-Abdominal Pressure status using Mann Whitney Test

Parameter	IAP	N	Mean	SD	Mean Diff	P-Value
Blood Urea	Raised	34	85.29	32.45	22.61	0.02*
	Normal	16	62.68	34.40		
S. Creatinine	Raised	34	2.79	1.61	0.98	0.002*
	Normal	16	1.81	0.71		
AST	Raised	34	350.26	1174.12	251.76	0.69
	Normal	16	98.50	227.66		
ALT	Raised	34	302.50	1062.43	218.19	0.82
	Normal	16	84.31	232.21		
PT	Raised	34	2.91	7.54	1.72	- 0.12
	Normal	16	1.19	0.61		

Mean blood urea level in patients with elevated IAP was 85.29, whereas in normal IAP group the value was 62.68, infering blood urea levels were significantly raised in group with elevated IAP, and this correlation between blood urea levels and elevated IAP was found to be statistically significant with p value of 0.02. Mean serum creatinine in patients with elevated IAP was 2.79; whereas in normal IAP group the value was 1.81,infering serum creatinine levels were significantly raised in group with elevated IAP, and this correlation between serum creatinine levels and elevated IAP was found to be statistically significant with p value of 0.002. Other blood tests like liver enzymes levels were done but there was no statistically significant correlation established with those blood tests as shown in [Table 14].

Table 15: Comparison of mean Urine Output (in ml/ day) based on Intra-Abdominal Pressure status using Mann Whitney Test

Parameter	IAP	N	Mean	SD	MeanDiff	P-Value
Urineoutput -	Raised	34	1069.75	470.938	-287.14	0.04*
	Normal	16	1356.89	554.35		

Mean urine output per day in patients with elevated IAP was 1069.75 and mean urine output in patients with normal IAP was 1356.89,infering the mean urine output is significantly lesser in raised IAP group than in normal IAP group and is statistically significant with p value of 0.04 as shown in [Table 15].

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Table 16: Comparison of mean SOFA scores based on varying grades of Intra-Abdominal Pressure using Kruskal Wallis Test

Grades	N	Mean	SD	Min	Max	P-Value
Grade I	17	4.30	1.86	1.7	8.3	0.002*
Grade2	16	7.08	1.78	3.3	10.2	
Grade3	I	8.20		8.2	8.2	

Mean SOFA scores were compared based on varying grades of intra-abdominal hypertension (IAH), it was found that mean SOFA score in people with grade 1 IAH was 4.30; in grade 2 IAH group it was 7.08 and in grade 3 IAH group it was 8.20, and it was found that with increasing grade of intra-abdominal hypertension patients were found to have higher SOFA score, and the correlation between SOFA score and intra-abdominal hypertension was found to be statistically significant with p value of 0.002 as shown in [Table 16].

Table 17: Comparison of mean APACHE 2 score based on Intra-Abdominal Pressure status using Mann Whitney Test

Parameter	IAP	N	Mean	SD	Mean Diff	P-Value
APACHE2	Raised	34	19.26	5.85	3.95	0.02*
	Normal	16	15.31	4.95		

APACHE 2 score, was calculated at the time of admission to ICU and it was seen that in patients with elevated IAP, the mean APACHE 2 score was found to be 19.26 and in normal IAP group it was found to be 15.31, hence infering significantly higher APACHE 2 score in raised IAP group as compared to normal IAP group, and the correlation between the APACHE 2 score and raised IAP was found to be statistically significant with p value of 0.02 as shown in [Table 17].

Table 18: Comparison of Rifle's Criteria based on Intra-Abdominal Pressure among study patients using Chi Square Test

Variable	Category	Raised		Normal		^{2}Value	P-Value
		n	%	n	%		
Rifle Criteria	No Risk	0	0.0%	2	12.5%	8.439	0.04*
	Injury	9	26.5%	7	43.8%		
	Risk	17	50.0%	6	37.5%		
	Failure	8	23.5%	1	6.3%		

In raised IAP group of patients, about 26.5% of patients had acute kidney injury as per RIFLE criteria; however in normal IAP group about 43.8% of the patients had acute kidney injury. Also in raised IAP group; about 50% of the patients had risk of developing acute kidney injury, whereas in normal IAP group the risk was 37.5%. In raised IAP group, about 23.5 % had acute renal failure whereas only 6.3% of the patients in normal IAP group had acute renal failure, henceinfering the positive correlation between the risk of developing

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acute kidney injury in raised IAP condition, and also positive correlation between raised IAP and acute renal failure, and both the correlations were found to be statistically significant in our study with p value of 0.04 as shown in [Table 18].

Table 19: Comparison of different Management Modalities based on Intra-Abdominal Pressure among study patients using Chi Square Test

Variable	Category	Raised		Normal		^{2}Value	P-Value
		n	%	n	%		
Need for Ionotropicdrugs	Yes	15	44.1%	5	31.3%	0.751	0.39
	No	19	55.9%	11	68.8%		
Need for Ventilator	Need Ventilator	11	32.4%	6	37.5%	0.407	0.82
	Need for NIV	7	20.6%	4	25.0%		
	No	16	47.1%	6	37.5%		
Dialysis	Yes	14	50.0%	4	26.7%	2.185	0.14
	No	14	50.0%	11	73.3%		

In our study, few patients were on inotropic support, few were on mechanical ventilation and few were initiated on hemodialysis in view of worsening renal function. It was found that 44.1 % of the patients with elevated IAP were on inotropic support in comparison to 31.3% of patients in normal IAP group. About 32.4% of the patients in raised IAP group were on mechanical ventilator support, 20.6 % were on Nivsupport, in comparison to normal IAP group where 37.5% of the patients were on mechanical ventilator support and 25 % of patients were on NIV. About 50% of the patients in raised IAP group were initiated on hemodialysis, in comparison to 26.7% of the patients in normal IAP group who were initiated on hemodialysis. However the correlation of raised IAP with inotropic support, mechanical support and initiation of hemodialsyis were not found to be statistically significant in our study as shown in [Table 19].

Table 20: Comparison of different value ranges of APACHE 2 scores with IAP status among study patients using Chi Square Test

Variable	Category	Raised		Normal		^{2}Value	P-Value
		n	%	n	%		
APACHE2	0-4	1	2.9%	0	0.0%	8.577	0.20
	5-9	1	2.9%	1	6.3%		
	10-14	4	11.8%	7	43.8%		
	15-19	10	29.4%	4	25.0%		
	20-24	14	41.2%	4	25.0%		
	25-29	3	8.8%	0	0.0%		
	30-34	0	0.0%	0	0.0%		
	>34	1	2.9%	0	0.0%		

In our study, among the patients with raised IAP, about 41.2 % of the patients had APACHE 2 score between 20-24, about 29.4% of the patients had score between 15- 19, about 11.8% of

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the patients had the score between 10-14, 8.8% of the patients with raised IAP had APACHE 2 score between 25-29,about 2.9% of the patients with raised IAP had score between 0-4 and 2.9% of the patients had score between 5- 9, 2.9% of the patients had score >34 as shown in [Table 20].

Table 21: Comparison of Outcomes based on Intra-Abdominal Pressure among study patients using Chi Square Test

Variable	Category	Raised		Normal		^{2}Value	P-Value
		n	%	n	%		
Outcome	Shift out	18	52.9%	13	81.3%	3.873	0.14
	DAMA	8	23.5%	1	6.3%		
	Death	8	23.5%	2	12.5%		

In our study we compared the outcome of the admitted patients in ICU, with raised intra-abdominal pressure, 52.9% of the patients with raised IAP at the time of admission, however improved eventually during ICU stay and were shifted out and got discharged. About 23.5% of the patients went Discharge against medical advice during treatment course in the hospital, and about 23.5% of the patients with elevated Intra-abdominal pressure died as depicted in [Table 21].

Table 22: Outcomes based on different grades of IAP

IAP	Shift out		DAMA		Death		^{2}Value	P-Value
	n	%	n	%	n	%		
Normal	13	81.3%	1	6.3%	2	12.5%	10.302	0.11
Grade1	11	64.7%	2	11.8%	4	23.5%		
Grade2	7	43.8%	5	31.3%	4	25.0%		
Grade3	0	0.0%	1	100.0%	0	0.0%		

Among the patients with normal IAP i.e about 81.3% of the patients were shifted out from ICU following recovery, about 12.5% of patients in normal IAP group died, however mortality rate was slightly higher in elevated abdominal pressure group, especially in grade 2 IAH, about 25% of the patient died. Mortality rate in Grade 1 hypertension was 23.5%.However the correlation was not statistically significant as depicted in [Table 22].

Discussion

Results of this study showed that raising intra-abdominal pressure and intra-abdominal hypertension was associated with significant risk of acute kidney injury. Among 50 patients included in our study, 33 patients were male and 17 were female. In our study, predominant age group with raised intra-abdominal pressure (about 42 % of the patients) was between 41-60 years of age. In study conducted by lakshmi et al mean age group of patients with IAH was obtained as 63.08 ± 12.37 years.[4]

Out of 44 patients with elevated intra-abdominal pressure on day one, 32 patients were male and 12 were female. In our study prevalence of intra-abdominal hypertension was 68%, it

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was more males. Study conducted by sreelatha.et.al,[10] prevalence of Intra-abdominal hypertension at the time of admission was 21.2%.In the study conducted by lakshmi et al,[4] prevalence of intra-abdominal hypertension was more in males. But in study conducted by Deeren and De Potter along with Malbrain et al,[5] demonstrated that the prevalence is more common in females than males.

On the day of admission about 40 patients (80% of the patients) had elevated IAP and 10 patients (20%) had normal IAP, in study conducted by Manu. L.N.G Malbrain et al,[6] which included 265 patients, on admission 140 patients(67.9%)had normal IAP, i.e<12mmHg, 85(32.1%) had IAP>12mmHG and 11(4.2%) had abdominal compartment syndrome(ACS).

In our study, about 28% of the patients had fever as the predominant symptom, 28% of the patients had breathlessness as main symptom, 18% had cough, 10% had swelling and numbness in lower limbs, 8% of the patients had vomiting, 8% of the patients had pain abdomen, 8% had altered sensorium, 8% had burning micturition, 6% had low urine output, 4% had loose stools, 4% had lower limb weakness and slurred speech, 4% had uncontrolled sugars, 2% had come with altered sleep cycle and 2% presented with history of consumption of OP poison.

About 66% of the patients involved in the study had diabetes mellitus, 48% of the patients had hypertension, 16% of the patients had Ischemic heart disease (IHD), 4% had chronic parenchymal liver disease (CLD), 14% of the patients had chronic renal disease (CRD), and 12% of the patients had chronic obstructive pulmonary disease (COPD)/Asthma. In study conducted by Lakshmi,[4] et al, among the 80 patients, 15 had chronic kidney disease (CKD) (18.4%), 45 had diabetes mellitus (56.3%), 50 had hypertension (62.5%), 17 had chronic liver disease (CLO) (21.3%), 28 patients had chronic obstructive pulmonary disease (COPD) (35%), 13 had Acute coronary syndrome (ACS) (16.3%) and 5 had acute respiratory distress syndrome (ARDS) (6.3).

In our study, it was found that about 55.9% of the people with raised IAP had diabetes mellitus and 44.1% of the patients did not have diabetes mellitus. Hence in our study, it was seen that raised intra-abdominal pressure was seen more in diabetics when compared to non-diabetics.

About 38% of the patients involved in the study had pneumonia with sepsis as a causative factor for AKI. About 18% of the patients had urosepsis with AKI. About 10% of the patients had cardio-renal and hepatorenal syndrome as a causative factor for AKI. About 8% of the patients had gangrene with sepsis and AKI, 6% of the patients had pyelonephritis with sepsis and AKI, 4% had acute gastro enteritis (AGE) with sepsis and AKI, 4% of the patients had pancreatitis with sepsis and AKI, 4% of the patients had necrotizing fascitis with sepsis and AKI,4% had meningo- enchephalitis and sepsis with AKI, 4% of the patients had cellulitis and puerperal sepsis. In study conducted by lakshmi et al,[4] with 80 patients, the risk factors assessed were mainly sepsis (13/80); ascites (6/80); pancreatitis (4/80) ; UGI bleed (5/80); post-surgery (10/80); CCF (9/80) and metabolic encephalopathy (7/80). In the study conducted by Shigehiko Uchino et al,[11] it was found that sepsis with septic shock was the predominant factor for acute renal failure.

About 97.1 % of the patients with raised intra-abdominal pressure had sepsis, with source of sepsis being predominantly, pneumonia in sepsis (about 32.4%). Cullen et al,[8] conducted studies on the effect of IAH on pulmonary compliance and found that those lung conditions

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which affect the abdominal wall compliance is associated with an increased incidence of IAH.

Other sources of sepsis in our study were like urosepsis without pyelonephritis (17.6%) pyelonephritis (8.8%), Meningoencephalitis (5.9%), Necrotising Fasicitis (5.9%), Pancreatitis (5.9%), Acute GE (5.9%), Gangrene with Sepsis (8.8%), Cellulitis / Puerperal sepsis (5.9%), Cardio / Hepatorenal (2.9% causes were also present. In a prospective study of 40 patients with septic shock who received massive volume resuscitation in the initial 24 hours of ICU admission, 34 patients (82.7%) developed IAH and 10 (25%) developed ACS,[7] Various studies conducted by Malbrain et al.[9] in tertiary care centres identified UGI Bleed, presence of ascites and metabolic encephalopathy as the risk factor for IAH. In study conducted by sreelatha et al, IAH was significantly correlated with risk factors like sepsis, mechanical ventilation, pancreatitis, capillary leak, ascites, cumulative fluid balance and cirrhosis.[10] 1n the study conducted by Manu L.N.G Malbrain abdominal surgery, fluid resuscitation, ileus and liver dysfunction were found to be independent predictors of Intra-abdominal hypertension(IAH). About 2.9% of the patients in our study with elevated intra-abdominal pressure, had hepatorenal syndrome. Hepatorenal syndrome is characterized,[15] by severe intra-renal vasospasm as a consequence of imbalance between vasodilatory and vasoconstrictive mediators seen in decompensated liver disease.

In our study, out of 50 patients, 4% of patients had pancreatitis, and in raised IAP group about 5.9% of the patients had pancreatitis with sepsis. In study conducted by Vimal Bhandari et al,[16] presence of IAH in the setting of acute pancreatitis was associated with severe disease, with increased risk of development of infected pancreatic necrosis ($p=0.076$) and a significantly longer hospital stay ($p=0.0054$) with ACS being associated with multiple organ failure and mortality among patients with severe disease (all p-values <0.01). It was concluded in their study that routine transvesical pressure measurements in all patients with manifest organ failure or APACHE II score 8 should be offered IAP surveillance. In study conducted by Jose Manuel Hidalgo,[17] Rosas et all, IAP measurement was found as good prognostic marker of the evolution and complications of acute pancreatitis.

In our study, among the raised IAP group of patients, about 26.5% of patients had acute kidney injury as per RIFLE criteria; however in normal IAP group about 43.8% of the patients had acute kidney injury. Also in raised IAP group, about 50% of the patients had risk of developing acute kidney injury, whereas in normal IAP group the risk was 37.5%. In raised IAP group, about 23.5 % had acute renal failure whereas only 6.3% of the patients in normal IAP group had acute renal failure; hence infering the positive correlation between the risks of developing acute kidney injury in raised IAP condition, and also positive correlation between raised IAP and acute renal failure. Dalfino et al,[2] prospectively investigated the relationship between IAH and ARF using RIFLE criteria,[12] in all patients admitted to a general ICU over a period of 6 months.

In our study, correlation between blood urea levels and elevated IAP was found to be statistically significant, with elevated blood urea levels in raised IAP group when compared to normal lAP group. Similarly serum creatinine levels were higher in raised IAP group when compared to normal IAP group and the correlation was statistically significant. In study conducted by Sabry A. Gohar et al,[18] there was significant positive correlation established between acute kidney injury and elevated IAP.

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In our study mean hemoglobin (Hb) was 10.54 in a group with raised intra-abdominal pressure, and was 10.61 in group with normal IAP and there was no statistically significant correlation between hemoglobin values and elevated IAP. In study conducted by Sabry A. Gohar et al,[18] it was seen that there was significant positive correlation of IVPI (intra-vesical pressure after 48hrs from ICU admission) (measured in using Pearson's test) between IVP l and haemoglobin and significant negative correlation between IVPl and AST, INR.

In our study, the mean urine output is significantly lesser in raised IAP group than in normal IAP group and is statistically significant. In 1947, Bradley and Bradley,[14] published a seminal study of the renal effects of elevated IAP in humans. In this study, patients underwent direct measurements of renal vein pressure, IVC pressure (as a surrogate marker for IAP), renal plasma flow, and glomerular filtration rates while the IAP was raised by external compression to approximately 20 mmHg. The effective renal plasma flow dropped, on average, by 24.4%, whereas the average drop in GFR was 27.5%. All patients became oliguric with an average reduction in urine flow of 57.4%.

In our study, and it was found that with increasing grade of intra-abdominal hypertension patients were found to have higher SOFA score, and the correlation between SOFA score and intra-abdominal hypertension was found to be statistically significant.

In another prospective study involving about 83 ICU patients,[13] those with IAH were found to have significantly higher mortality (P 0.02) and higher incidence of renal dysfunction by Sequential Organ Failure Assessment renal subscore (P 0.006).In our study, it was seen that in patients with elevated IAP, the mean APACHE 2 score was found to be 19.26 and in normal IAP group it was found to be 15.31, hence infering significantly higher APACHE 2 score in raised IAP group as compared to normal IAP group, and the correlation between the APACHE 2 score and raised IAP was found to be statistically significant with p value of 0.02.

In our study in our study, among the patients with raised IAP, about 41.2 % of the patients had APACHE 2 score between 20-24. In study conducted byisabel M Murcia-Saez et al,[19] there was positive correlation established between IAP and APACHE (Acute Physiology And Chronic Health Evaluation) II score. In the study conducted by annikareintamblaser et al,[20] the admission day variables which were found to be independently associated with the presence or development of IAH, included APACHE II greater than or equal to 18.

In our study, few patients were on inotropic support, few were on mechanical ventilation and few were initiated on hemodialysis in view of worsening renal function. It was found that 44.1 % of the patients with elevated IAP were on inotropic support in comparison to 31.3% of patients in normal IAP group. About 32.4% of the patients in raised IAP group were on mechanical ventilator support, 20.6 % were on Niv support.in comparison to normal IAP group where 37.5% of the patients were on mechanical ventilator support and 25 % of patients were on NIV.

In our study, about 50% of the patients in raised IAP group were initiated on hemodialysis, in comparison to 26.7% of the patients in normal IAP group who were initiated on hemodialysis, however statistically significant correlation wasn't established. In study conducted by Isabel M Murcia-Saez et al,[19] higher IAP values were independently associated with need for dialysis. In study conducted by sreelatha et al,[10] about 37.5% of the patients needed renal replacement therapy and all were in IAH group.

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Among the patients with normal IAP i.e about 81.3% of the patients were shifted out from ICU following recovery, about 12.5% of patients in normal IAP group died, however mortality rate was slightly higher in elevated abdominal pressure group, especially in grade 2 IAH, about 25% of the patient died. Mortality rate in Grade 1 hypertension was 23.5%.However the correlation was not statistically significant. In study conducted by annikareintamblaser et al,[20] the presence and severity of IAH during the first 2 weeks of the ICU stay significantly and independently increased 28- and 90-day mortality, whereas the presence of IAH on the day of ICU admission was insufficient to predict these adverse outcomes.

Conclusion

It was found that with increasing grade of intra-abdominal hypertension patients were found to have higher SOFA score, and the correlation between SOFA score and intra-abdominal hypertension was found to be statistically significant. In our study, it was seen that in patients with elevated IAP, the mean APACHE 2 score was found to be significantly higher as compared to normal IAP group, and the correlation between the APACHE 2 score and raised IAP was found to be statistically significant .Among the patients with raised IAP, about 41.2 % of the patients had APACHE 2 score between 20-24.

In our study, it was found that 44.1 % of the patients with elevated IAP were on inotropic support in comparison to 31.3% of patients in normal IAP group. About 32.4% of the patients in raised IAP group were on mechanical ventilator support, 20.6% were on Nivsupport, in comparison to normal IAP group where 37.5% of the patients were on mechanical ventilator support and 25 % of patients were on NIV. About 50% of the patients in raised IAP group were initiated on hemodialysis, in comparison to 26.7% of the patients in normal IAP group who were initiated on hemodialysis. However the correlation of raised IAP with inotropic support, mechanical support and initiation of hemodialsyis were not found to be statistically significant in our study.

Outcome of the patients admitted in ICU was noted. About 23.5% of the patients with elevated Intra-abdominal pressure died. Mortality rate was slightly higher in elevated IAP group, especially in grade 2 IAH.

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