Intra-Abdominal Pressure Monitoring By Nurses For Early Detection Of Abdominal Compartment Syndrome And Early Decompressed Laparotomy In Comparison With Need To Laparotomy By Physical Exam

Rahim Ali Sheikhi*, Mohammad Heidari*

*Department of Nursing, School of Nursing and Midwifery, Shahrekord University of Medical Sciences, Shahrekord, Iran.

Abstract: Background& Objective:Abdominal compartment syndrome is as potentially lethal condition caused by any event that produces intra-abdominal hypertension. The most common cause is blunt abdominal trauma. Increasing intra-abdominal pressure affects much vital body system. Hemodynamic, respiratory, renal and neurological abnormalities are hallmark of ACS. All authors are agreeing that decompression laparotomy is the treatment of choice for the ACS. Nursing care involves vigilant monitoring for early detection including serial measurement of intra-abdominal pressure (from urinary bladder). This study was designed to investigate the comparative effect of measurement of intra-abdominal pressure and physical exam in patient with ACS for refer the patients to operation room. Methodology:In this research ACS was defined as abdominal distention with intra-abdominal pressure ≥15 mm Hg (20cm H_2O) accompanied by at least two of the following: oliguria or anuria, hypoxemia and hypotension or shock. When ACS detected by researcher, compared with diagnose of need to laparotomy by physician both timely and numerically.Results:Of 100 patients admitted over 8 months, 28 patients had abdominal compartment syndrome, 21 of this patients refer to operation room by physician. According to numeral comparison between two group not significant (P>.05) but according the time measuring abdominal pressure for detection of need to decompressed laparotomy significantly decreased than physical exam (p<.05).Conclusion:The ACS is a potentially lethal condition occurs in a significant number of severely blunt abdominal trauma patients and it develops quickly. Preventative therapy should be instituted to minimize its development in patients at risk and monitoring of intra-abdominal pressure may allow prompt treatment of this condition rather than physical exam.[Heidari M NJIRM 2016; 7(2):18-23]

Key Words: Intra-Abdominal Hypertension; Abdominal Compartment Syndrome; Physical Examination.

Author for correspondence: Mohammad Heidari, Department of Nursing, School of Nursing and Midwifery, Shahrekord University of Medical Sciences, Shahrekord, Iran.Email:mo.heydari@yahoo.com

Introduction: An increase of pressure within one or more muscle compartments can lead to tissue hypoxia with irreversible damage to soft tissue. It has been known for years that, in a similar way, an increase in abdominal pressure can lead to the so-called abdominal compartment syndrome (ACS) [1].Kron and associates first used the term ACS in the 1980, and it is now broadly defined as organ dysfunction attributable to increased intra-abdominal pressure (IAP) [2]. ACS is a clinical entity that is developed from an acute and rapid elevation of IAP[3]. Any abnormality that elevates the pressure within the abdominal cavity can induce intra-abdominal hypertension. They include acute pancreatitis, ruptured abdominal aortic aneurysm, spontaneous incidents inside the abdomen, hem peritoneum, intestinal obstruction, ileus, intra abdomen infections,mesenteric veins thrombosis, intestinal ischemia, abdominal traumas, retroperitoneal bleeding, aorta surgery, reduction of large hernias,liver transplantation, after surgery incidents (acute abdomen distention, accumulation of blood within the abdominal cavity) and other causes (burning, massive volume replacement etc.) [2,4,5]. Compartment syndrome is, often observed during the first 24 hours after intra-abdominalhypertension and surgery [6]. The normal IAP is zero (that is, atmospheric). Intra-abdominal hypertension causes changes in almost all organ systems. The clinicalpresentation of compartment syndrome is also related to cardiovascular, kidney and respiratory systems [6,7]. The cardiovascular system is affected by decreasing venous return to the heart due to compression of the inferior vena cava by high pressure in the peritoneal space [8,9]. In addition, this increased pressure also enhances systemic vascular resistance impairing left ventricular ejection. The combination of decreased venous return and increased after load leads to a precipitous decrease in cardiac output adding to the ischemia [10]. Elevated pressure in the abdomen impedes diaphragmatic excursion reducing functional residual capacity and consequently exacerbating the increasing oxygen debt.

Compression of renal veins and collecting systems by high intra peritoneal pressure causes a dwindling urine output progressing to oliguria even when blood pressure is normal. Kidney ischemia also promotes activation of the renin angiotensinaldosterone system.

If prolonged, these responses progress to acute tubular necrosis and renal failure [8,11].The ACS is a potentially lethal condition and the mortality of ACS is high. Recognizing patient at risk, monitoring for sign of ACS, and early initiation of treatment could help to reduce morbidity and mortality of the syndrome [12]. Abdominal decompression (decompressed laparotomy) is the only treatment for ACS [13]. Immediate diagnosis and emergency treatment of intra abdomen hypertension and ACS, decreases mortality rate. ACS is characterized by increased IAP (which is measured via a Foley catheter inserted to bladder) and two or more of the symptoms as follows: oliguria, respiratory distress, and hypoxia, reduction in cardiac output, hypotension and acidosis [14,15].

Prevention is better than cure. Every clinician specially nurses should remember the risk factors for intra abdomen hypertension and be vigilant to avoid the progression of ACS [1,16]. By measuring the IAP through the bladder, a quick and accurate assessment of whether the IAP is elevated and can it be performed by emergency or critical care nurses without a specific medical order or sophisticated invasive monitoring equipment [1]. Trauma nurses play an essential role in the early detection of this syndrome [17,18]. Knowledge of nurses about risk factors and clinical symptoms of intra abdomen hypertension could reduce death caused by this syndrome [19].

Nurses caring for any patient at risk must remain vigilant to prevent ACS by watching closely for the hallmark renal, pulmonary, cardiovascular, and neurological signs that indicate the development of this syndrome [20]. Patients who have low urinary output and hypotension shock, are unresponsive to fluid resuscitation, or who have increased peak airway or intra cranial pressures should be considered at risk of ACS [21,22]. Nursing care involves vigilant monitoring for early detection including serial measurements of IAP[1]. Mortality rate is high in ACS, and the current treatment of patients with ACS is urgent decompressed laparotomy, either in the operating room or at the bedside [20,23]. Nowadays, IAP measurement for diagnosis of ACS to decide for transferring patients to the operating room is not used in Iran, and the physicians decide only based on physical examinations and diagnostic equipment such as sonography, CT scan etc. to perform laparotomy.

The researcher intended to detect the patients affected by ACS via IAP measurement and with related clinical signs (needing an urgent laparotomy), and then compared this diagnosis with diagnosis of surgeons (the need for laparotomy based on physical examination and diagnostic equipment such as sonography, CT scan etc.) with regards to the number of diagnosis and also the length of waiting time up to surgery.

Material and Methods: This research was a descriptive-analytical study in which patients traumatized with blunt trauma to abdomen who referred to the emergency ward in Nemazi hospital (Shiraz, Iran) were studied.The diagnosis of ACS requires: 1. recognition of patients at risk. 2. Detection of clinical manifestations and 3. Measurement IAP [18,23]. The patients at risk in this study included those who had blunt trauma to abdomen. The typical clinical manifestations included tensely distended abdomen, decreased cardiac output, hypoxia, hyper apnea, hypotension and oliguria [19]. Measurement of intra vesicle or urinary bladder pressure can be used as an indirect method to determine IAP. In this method an indwelling urinary (Foley) catheter is inserted in to the bladder and the bladder is emptied. The drainage bag is then clamped off, and 60 ml of sterile isotonic sodium chloride solution is instilled through the catheter tubing. When the volume in the bladder is between 50-100 ml, the organ acts as a passive diaphragm. With the patient in supine position and the symphysis pubis as a zero reference point, the catheter tubing is simply raised vertically above the symphysis pubis at a 90° angle to the patient pelvis. Then, the tubing is unclamped and the distance between the symphysis pubis zero point and the maximal height of the fluid column is recorded (in centimetres) [1,19,20].

Figure 1: Pressure increase inside the abdomen may cause what is named ACS. Increase IAP may cause changes in all organs. Death rate is high for compartment syndrome. And, the diagnosis of patients in danger, and monitoring them for the symptoms of the syndrome and precocious treatment could help decrease death rate for this syndrome

Tools for data collection included a check list consisting demographicinformation and other data required in this research, and IAPmeasurement instruments consisting a Foley catheter, Intra venous set, sterile isotonic sodium chloride, a syringe (50cc), sterile gloves and a ruler. We measured IAP every 4 hours until 24 hours after trauma. When intra abdomen pressure was above 20 cm of the water (15 mmHg), the researcher had to consider other symptoms such as decreased urine output, hypotension, respiration (Hypoxemia). If there were two symptoms out of these three symptoms along with intra abdomen hypertension, ACS (and therefore the need for emergency laparotomy) would be definitely diagnosed and recorded for the patient.

Then, the researcher waited and followed the subject to know the time of need for laparotomy by general surgeons' opinion based on physical exam or other methods such as sonography. Whenever the patient was transferred to the operating room, the researcher recorded the time, and then compared the time intervals of the need for laparotomy in two methods of physical exam conducted by surgeons and the measurement of IAP made by the researcher. In order to achieve our goal in this research, the data were collected from 100 patients who had experienced a blunt abdominal trauma and were referred to the Nemazi hospital in Shiraz. A questionnaire was filed for each patient and after measurement of IAP in all of the subjects who had entered the study; the collected data were analyzed by use t-test and chi square test.

Results: Among the 100 blunt trauma patients, 72 patients did not have compartment syndrome while 28 patients had. Among the subjects afflicted with ACS, 21 patients were transferred to the surgery room by physicians.Most of the patients with abdominal trauma (76%) whose intra abdomen hypertension was measured were between 15-39 years of age. Also, most of the patients who had ACS (64.28%) were 15-39 years old. About 7% of all patients and 4% of patients with ACS were 14 or under 14 years of age. About 17% of all patients and 28% of the patients with ACS were 40-75 years old.With regard to gender of the subjects, 87% of all abdominal trauma patients and 82.14% of the patients with ACS were male, and 13% of all patients and 17.86% of the patients with ACS were female.

Regarding the type of trauma, 49% of all patients and 57.14% of the patients with ACS had a car accident. About 38% of all patients and 35.71% of the patients with ACS had a motorcycle accident. About 9% of all patients and 7.14% of the patients with ACS had a fall from a great height. About 4% of all patients referred to hospital because of straight blows to the abdomen while no patient was reported with this etiologic in the ACS group.From the aspect of incidents along with abdominal trauma, 19% of all patients and 46.42% of the patients with ACS had pelvic fracture along with abdominal trauma. About 8% of all patients and 10.71% of the patients with ACS had upper extremity injuries along with abdominal trauma.

About 15% of all patients and 17.85% of the patients with ACS also had lower extremity injuries. About 16% of all patients and 10.71% of the patients with ACS had head injuries. About 12% of all patients and 14.28% of the patients with ACS had multiple traumas. About 30% of all patients did not have any injuries other than abdominal trauma and there were no ACS patients among them.According to sonography results and findings from laparotomy, 8% of all patients and 17.25% of the patients with ACS were having liver injuries.About 3% of all patients and 3.5% of the patients with ACS had spleen injuries. About 15% of all patients and 35.7% of the patients with ACS had internal bleeding. About 4% of all patients were having a variety of different incidents and all of them (14.28%) had compartment syndrome. For 70% of all patients nothing was noticed through laparotomy and sonography and there were eight people (28.56%) who had ACS.

Regarding the amount of received fluids in the first 24 hours, the subjects not having ACS had received an average of 4493cc serum, 0.83 bag of packed cell, 0.19 bag of FFP, 0.07 unit platelets, respectively, and the subjects who had abdomen compartment syndrome received 6107cc serum, 3.86 bags of packed cell, 5.56 bags of FFP, 6.20 units of platelets, respectively.With regard to the complications in different body organs in the subjects who had abdomen compartment syndrome, 100% experiencedcardiovascular complications; 71.42% had kidney disorders; 57.14% had respiration disorders; 71.42% had cardiovascular along with kidney disorders; 57.14% had disorders in cardiac and respiratory system; 28.57% had disorders in three cardiovascular, respiratory and renal systems. With regard to patients' transfer to the surgery room,

ACS patients, 75% (21 patients) were transferred to the surgery room while 25% (7 patients) were not.

Regarding the outcomes, among all subjects sent to surgery room, 5 subjects (23.80%) survived and all subjects who were not sent to the surgery room expired.The mean waiting time interval for alive patients to be sent to the surgery room was 138 minutes while it was 146 minutesfor the expired patients.Regarding the time duration comparison for physical examination and intra abdomen pressure measurement, the mean time taken by the researcher to diagnose the ACS (and need to emergency laparotomy) was 95.48 minutes from patients' arrival, and it was 144.76 minutes for the physicians to diagnose of need to laparotomy and refer the patient to operation room.

Table 1: Demographics of patient groups by Age, Sex, mechanism of trauma, associated injury and refer or not refer to operation room, finding of sonography and amount of fluid resuscitation

Variables	Patients afflicted with ACS n=28 %	All patients whose IAP was measured n=100 N %
Age(years)		
≤14n=4	14.28%	n=7 7%
15-39n=18	62.28%	n=76 76%
40-75n=6	21.42%	n=17 17%
Sex		
Male n=23	82.14%	n=87 87%
Femalen=5	17.86%	n=13 13%
Mechanisms of trauma		
Car accidentn=16	7.14%	n=49 49%
Bike accident n=10	35.71%	n=38 38%
Fallingn=2	7.14%	n=9 9%
Direct trauma n=0	0%	n=4 4%
Associated injuries		
Pelvic fracturen=13	6.42%	n=19 19%
Upper extremityn=3	0.71%	n=8 8%
Lower extremityn=5	7.85%	n=15 15%
Head trauman=3	0.71%	n=16 16%
Multiple injuriesn=4	14.28%	n=12 12%
Nonen=0	0%	n=30 30%
Referral to the operating room for laparotomy		
Resultsn=21	75%	----------
Survived n=5	23.8%	
Expiredn=16	76.2%	
Not being referred to the operating room		
Results n=7	25%	----------
Survived n=0	0%	
Expiredn=7	100%	
Finding of sonography		
Liver injuriesn=5	17.25%	n= 8 8%
Spleen injuriesn=1	3.5%	n=3 3%
Internal bleedingn=10	35.7%	n=15 1%
Multiple injuries to internal organsn=4	14.28%	n=4 4%
Not any finding in sonographyn=8	28.56%	n=70 70%
Mean of fluid resuscitation in 24 hrs	6107cc	4493cc
Crystalloid fluid	3.86 bag	0.83 bag
Packed cell (1bag=250 cc)	5.56 bag	0.19 bag
FFP (1bag=250 cc)	6.20 bag	0.07 bag
Platelet (1 bag=50 cc)		

Table 2: The comparison of intra abdomen pressure measurement to diagnose ACS (and need to emergency laparotomy) and physical examinations to send patients to the surgery room regarding time duration

P value	Mean SD	Time average (from the time of arrival)/min	Method
<0.01	21.83	95.48	Intra abdomen hypertension measurement to diagnose ACS
<0.01	23.60	144.76	Medical examinations and transferred to the surgery room by the physicians

The above table indicates that the diagnosis of surgery room requirement for patients via intra abdomen pressure measurement method and reasonable diagnose of abdomen compartment, takes less time than physical examination method (p<0.01).

Discussion& Conclusion: Waele and et al. also conducted a research on 14 patients who were having ACS because of a revival shock. In their research 93% was male and 7% were female [5].With regard to the type of the injury, 57.14% had a car accident, 35.71% had a motorcycle accident and two subjects had fallen from high places causing them to have ACS. Chi square test showed that there was no special relationship between injury type and ACS (p>0.05). With regard to the injuries along with abdominal trauma, 46.42% had pelvis fracture, 10.71% had upper extremity fractures, 17.85% had lower extremity fractures, 10.71% had head injuries, and 14.28% had several injuries.Chi square test showed that there was a special

relationship between pelvis fracture and having ACS (p<0.001).

With regard tolaparotomy and sonography results in ACS patients, 17.25% had liver lacerations, 35.7% had internal bleeding, 3.5% had spleen laceration, 14.28% had a mixture of different complications, and 8.56% had none of the above mentioned complications.Chi square test showed that there was a significant relationship between intra-abdominal bleeding and liver laceration with ACS.Regarding received fluids (serum, FFP, Platelets and blood) in (the first) 24 hours, ACS patients had taken more fluids.T-test showed that there was a significant difference between the two groups of having ACS and not having ACS patients (p<0.00). The rate of having ACS was 28%.

In Malbrain research in which 145 laparotomy required patients were studied, compartment syndrome rate was 14.4% and through Christopher's research (1996-2000) on 72 patients, the compartment syndrome rate was 36%. Among ACS patients, 75% were sent to the surgery room by a doctor and 25% were not [13]. With regard to the comparison of physical examination method and intra abdomen hypertension measurement in surgery requirement diagnoses in intra abdomen hypertension measurement, 28 subjects and in physical examination method, 21 subjects were diagnosed to have surgery requirement respectively, with no significant difference (p=0.75).With regard to the comparison between the times taken by the researcher to diagnose patient's surgery requirement with the time taken by the surgeon, mean time duration from the patient's arrival untilresearcher's diagnosis was 95.48 minutes while the mean time duration from patient's arrival until surgeon's diagnosis of surgery requirement was 144.76 minutes. T-test showed that the mean time interval in intra abdomen hypertension measurement was significantly less than physical examination method (p<0.01).

The ACS is a potentially lethal condition occurs in a significant number of severely blunt abdominal trauma patients and it develops quickly. Preventative therapy should be instituted to minimize its development in patients at risk and monitoring of IAP may allow prompt treatment of this condition rather than physical exam.

References:

1. Spencer P, Kinsman L, Fuzzard K. A critical care nurse's guide to intra-abdominalhypertension and abdominal compartment syndrome. Australian Critical Care. 2008; 21: 18-2816.
2. Malbrain M, Chiumello D, Pelosi P, Bihari D, Innes R, Raniei V, et al. Incidence and prognosis of intra-abdominal hypertension in a mixed population of critically ill patients: a multiple-center epidemiological study. Critical Care Med. 2005; 33(2): 315-22.
3. Biffl W, Moore E, Burch J, Reginald J. Offner P, Johnson J: Secondary abdominal compartment syndrome is a highly lethal event. The American J of Surgery. 2001; 182: 645-648.
4. Sheikhei RA, Heydari M, Shahbazi S. Comparison of Intra-abdominal Pressure Measurement and Physical Exam for Diagnosis of Surgery Indication in Patients with Abdominal Compartment Syndrome due to Blunt Trauma. Journal of Kerman University of Medical Sciences. 2011;18(3):271-8.
5. Waele J, Lae I, Kirkpatrick A, Hoste E: Intra-abdominal Hypertension and Abdominal Compartment Syndrome. Am J Kidney Dis. 2010; 57(1): 159-169.
6. Cothren C, Moore E, Johnson J, Moore J: Outcomes in surgical versus medical patients with the secondary abdominal compartment syndrome. The American J of Surgery. 2007; 194: 804-808.
7. Scheppach W. Abdominal compartment syndrome. Best Practice & Research Clinical Gastroenterology. 2009; 23: 25-33.
8. Kowal Vern A, Ortegel J, Bourdon P, Chakrin A, Latenser B, Kimball D, et al. Elevated cytokine levels in peritoneal fluid from burned patients with intra-abdominal hypertension and abdominal compartment syndrome. Burns. 2006; 32: 563-569.
9. Ganeshanantham SR, Walsh, K. Varty. Abdominal compartment syndrome in vascular surgery-A review G. International J of Surgery. 2010; 8: 181-185.
10. Peppriell J, Bacon D. Acute Abdominal Compartment Syndrome with Pulse less Electrical Activity during Colonoscopy with Conscious Sedation. J of Clinical Anesthesia. 2000; 12: 216-219.
11. Spencer P, kinsman L, Fuzzard K. A critical care Nurses guide to intra-abdominal hypertension compartment syndrome. Australian J critical care. 2008; 21(1): 18-28.
12. World Society of Abdominal Compartment Syndrome Consensus Conference Definitions. In:

Inaugural World Congress-Abdominal Compartment Syndrome. 2004.
13. Malbrain M, Chiumello D, Pelosi P, Bihari D, Innes R, Raniei V, et al. Incidence and prognosis of intra-abdominal hypertension in a mixed population of critically ill patients: a multiple-center epidemiological study. Crit Care Med. 2005; 33(2): 315-22.
14. Berger P, Nijsten M, Paling J. His abdominal compartment syndrome: a complication with many faces. The Nether land J of Medicine. 2001; 58 (1): 197-203.
15. Meier Ch, Contaldo C, Schramm R, Holstein J, Hamacher J, Amon M, et al . A New Model for the Study of the Abdominal Compartment syndrome in rats. Journal of Surgical Research. 2007; 139: 209-216.
16. Schepp W. Abdominal compartment syndrome, best practice researched clinical gastroenterology. The J of Trauma. 2009; 23(1): 25-33.
17. Rollins. M, Volger S. Decomppressivelaparatomy for abdominal compartment syndrome in children: before it is too late. J of pediatric surgery 2010; 45(6): 1324-1329.
18. Loftus I, Thompos M. The abdominal compartment syndrome following aortic surgery. EurjVasc Surg. 2003; 20(1): 110-115.
19. Mcquillan K, Makic M, Whalen S. Trauma nursing from resuscitation through rehabilitation. 4th ed. Philadelphia: Saunders CO; 2009. pp. 678-704.
20. Rosen C. Emergency medicine. 7th ed. Philadelphia: Mosby CO; 2010. pp. 414-435.
21. Bouden D, Halliwell D. Emergency care and first aid for nurses. Philadelphia: Saunders CO; 2007. pp. 186-208.
22. Smeltzer S, Bare B, Hinkle J, Cheerer K. Medical-Surgical nursing. 11th ed. Philadelphia: Lippincott Williams wilkins; 2008.
23. Black J M. Hawks J H. Medical-Surgical Nursing. 7th ed. Philadelphia: Elsevier Saunders; 2005.

Conflict of interest: None

Funding: None

Cite this Article as:Sheikhi R, Heidari M. Intra-Abdominal Pressure Monitoring For Early Detection Of Abdominal Compartment Syndrome. Natl J Integr Res Med 2016; 7(2): 18-23