

# The effects of nursing activities on the intra-abdominal pressure of patients at risk for intra-abdominal hypertension

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## Abstract

**Background:** Intra-abdominal hypertension (IAH) occurs frequently in critically ill patients, and adds to their morbidity and mortality. There is no published evidence on the effects of nursing activities on the intra-abdominal pressure (IAP) for patients at risk of IAH. The purpose of this study was to identify the effects of hygiene care on the IAP of patients at risk for IAH.

**Methods:** Hygiene care was provided to 34 at-risk patients. IAP was measured prior to initiating the hygiene care, immediately after and 10 minutes later. This was a quasi-experimental, pre-test/ post-test design.

**Results:** The 10 minute post-hygiene care measurement of the IAP was significantly lower than the pre or immediate post-measurement of the IAP. There were no significant changes in the mean arterial pressure (MAP) or the abdominal perfusion pressure (APP).

**Conclusions:** It is safe and possibly therapeutic to provide hygiene care to patients at risk for IAH.

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**Key words:** nursing activities, intra-abdominal pressure; intra-abdominal hypertension; physiologic monitoring

There is abundant evidence that intra-abdominal hypertension (IAH), occurs frequently in critically ill patients [1, 2]. It has been identified as increasing the morbidity and mortality of such patients. The nurse is the one who performs the measurements and alerts the health care team of rising intra-abdominal pressures. Much research has been done on the effects of patient positioning and its effect on IAP [3–5]. However, there has been no nursing research on the effect of what nurses do to their patients and the effect on IAP.

Past nursing studies have identified the effects of nursing care on neurosurgical patients' intracranial pressure (ICP) [6, 7], and cardiac patients' mixed venous oxygen saturation (SVO<sub>2</sub>) [8–12]. The studies found that performing consecutive nursing activities had deleterious effects on both ICP and SVO<sub>2</sub>. The recommendation was to titrate nursing care and allow the patients' ICP or SVO<sub>2</sub> to equilibrate.

Intra-abdominal pressure (IAP) is defined as the steady state pressure within the abdominal cavity [13, 14]. In the normal individual, IAP may range from 0 to 5 mm Hg. It

varies inversely with intra-thoracic pressure during normal breathing. However, various factors can cause it to increase drastically for short periods, such as with a cough, sneeze, and then return easily to baseline.

Critically ill patients tend to have an average IAP of 5 to 7 mm Hg [13, 14]. Persistent elevations  $\geq 12$  mm Hg are defined as IAH [13]. Abdominal compartment syndrome (ACS) is defined as a sustained IAP  $> 20$  mm Hg (with or without an abdominal perfusion pressure (APP)  $< 60$  mm Hg) that is associated with new organ dysfunction/failure [13]. APP is calculated by subtracting the IAP from the mean arterial pressure (MAP – IAP = APP) [13]. The MAP normal range is from 70–100 mm Hg [15]. The Abdominal Compartment Society (formerly known as the World Society of the Abdominal Compartment Syndrome [WSACS]) guidelines recommend keeping the APP  $> 60$  mm Hg for patients at risk for IAH or ACS [14].

The purpose of this study is to assess the effects of a specific and common nursing activity, which is hygiene care, on the IAP of patients who are at risk for IAH.

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## **METHODS**

### **PROTECTION OF HUMAN SUBJECTS**

The study was approved by the Investigational Review Board (IRB) of the hospital system. This study was requested as an expedited review as no experimental treatments took place. The hygienic procedures carried out by nurses, for all patients, are an accepted and expected practice. Measuring IAP for those at risk is evidence-based and based on the legal prerogative of the physician. Consent for the nursing activities and IAP measurement are covered under the general consent for treatment the patient signs on admission to hospital.

### **RESEARCH DESIGN**

A pre-experimental one group pre-test-post-test design was used to identify differences in IAP at rest and IAP after a nursing activity.

### **SETTING**

The setting was a 145-bed non-profit community hospital in south Florida. The hospital provides general medical and surgical services, as well as obstetrics, paediatrics, and emergency services. The hospital serves suburban and rural populations. The CCU is a 15-bed unit that cares for both medically and surgically ill patients that require critical care services.

### **SAMPLING STRATEGIES**

A non-probability sampling technique was used as the sampling strategy. A convenience sample of patients meeting the eligibility criteria admitted to the CCU was used. The weaknesses of this sampling plan are that there is a risk for bias and questionable generalizability to the entire population. The strength is that the subjects were easily accessible to the researcher.

### **ELIGIBILITY CRITERIA**

#### **INCLUSION CRITERIA**

The inclusion criteria for this study was of an adult patient aged 18 or older, admitted to the CCU with an indwelling urinary catheter in place. The criteria for patients at risk for IAH used the Abdominal Compartment Society's 2006 guidelines [13, 14] as this study was carried out prior to the publication of the Abdominal Compartment Society's 2013 guidelines [2]. The patient met at least one criterion and two risk factors for IAH. The criteria were as follows: new admission to a critical care unit (CCU) or the presence of new or progressive organ failure.

#### **EXCLUSION CRITERIA**

Any individual that did not meet the Abdominal Compartment Society risk factors were excluded. Further excluded were any individuals that did not have an indwelling

urinary catheter or had bladder trauma, bladder surgery, or neurogenic bladder; such patient conditions preclude an accurate IAP reading via the urinary catheter [16]. As only patients admitted to the CCU were to be included, patients admitted to other units were excluded.

### **DETERMINATION OF SAMPLE SIZE: POWER ANALYSIS**

A priori calculation was carried out in order to identify the optimal number of subjects for this study. In order to reduce the likelihood of committing a Type I or a Type II error, the alpha ( $\alpha = 0.05$ ) and power ( $1 - \beta$  error probability = 0.80) had been set beforehand. Anticipating a moderate effect size and using a two-tailed t-test of two dependent means for matched pairs, G\*Power software [17] indicated that a total sample of 34 was needed. Allowing for the potential for up to 20% attrition due to incomplete data sets, procedure violations, and patient dropout, a total of 41 individuals were planned to be recruited.

### **PROCEDURES**

Patients were accepted into the study once they had met the eligibility criteria. The nurse screened the patient for risk factors of IAH and initiated the nurse-driven protocol, or one upon a physician's order. The primary investigator (PI) measured IAP at rest. The PI then performed the nursing activities consisting of oral hygiene, a bed bath, one minute back rub and linen change. The IAP was measured immediately after these nursing activities and again 10 minutes later.

The procedure for measuring IAP followed the recommendations of the Abdominal Compartment Society [13, 14]. Intra-abdominal pressure was measured by means of the AbViser Autovalve produced by AbViser, Wolfe-Tory Medical, Salt Lake City, USA (now by Convatec). This device is a pre-assembled kit that contains a closed system set-up (ABV 300). The Abdominal Compartment Society has deemed the AbViser as an acceptable, reliable tool for measuring IAP. The IAP was measured at end-expiration in the complete supine position after ensuring that abdominal muscle contractions were absent and with the transducer zeroed at the level of the mid-axillary line at the iliac crest. Twenty millilitres of sterile normal saline were instilled into the bladder via the AbViser. The PI then waited approximately 30–45 seconds for bladder detrusor muscle relaxation and for the bedside monitor to equilibrate before taking the reading. This reading and the calculated APP were recorded in the electronic medical record (EMR).

### **HYGIENE ACTIVITY**

A measurement of the IAP was taken in the supine position with the head of the bed flat prior to the start of the hygiene activity. If the patient was receiving mechanical ventilation, oral hygiene was given with a pre-packaged oral

care kit that included a toothbrush, plaque removal solution, and lip emollient. The patient was suctioned orally prior to the hygiene procedure and afterwards. If the patient was breathing spontaneously, the patient would either brush his or her own teeth with a toothbrush and toothpaste or the PI would perform this if the patient was too weak to do so. The bed bath entailed cleansing the patient starting with the head and face, proceeding to the right and then the left arm. The torso would be cleansed next, along with the right and then the left leg. If present, an anti-embolic hose and/or a sequential compression device for the calves were removed. The genitalia were then cleansed. One of the staff nurses would assist the PI in turning the patient first to the patient's left side where the back and buttocks were cleansed and a one-minute backrub using the effleurage technique was provided. The linens were then changed in the standard fashion of an occupied bed. A clean fitted sheet, draw sheet, and underpad were applied to the right side of the bed, as the dirty sheets were rolled to the centre of the bed. The patient was then turned to the right to complete the linen change. Upon completion of the linen change, the patient was placed supine with head of bed flat for the immediate post-measurement of the IAP. The patient remained in this position until the last reading was taken. Ten minutes after the post-bath reading, the last IAP reading was taken. Then, the anti-embolic hose and/or sequential compression calf device were replaced. The patient was then placed in a position of comfort.

### DEMOGRAPHIC INFORMATION

Demographic data were collected, including age, gender, body mass index (BMI), CCU diagnosis, along with the Acute Physiology and Chronic Health Evaluation (APACHE II) score and the Sequential Organ Failure Assessment Score (SOFA). The length of stay in CCU when the IAP was measured and the criterion and risk factors for IAH were collected. The pre- and post-nursing activity measurements of IAP and abdominal perfusion pressure (APP) were also collected.

The Centers for Disease Control (CDC) identifies a BMI less than 18.5 as underweight, 18.5–24.9 as normal, 25–29.9 as overweight, and 30 or greater as obese [18]. In addition, the APACHE II scoring system is a valid and reliable severity of illness tool that is closely correlated with in-hospital risk of death [19]. The scores may range from 0–71; the higher the score, the more severe the illness and the higher the risk of death. The Sequential Organ Failure Assessment (SOFA) is a scoring system used to determine a critically ill patient's rate of organ dysfunction or failure [20]. The scores may range from 0–24; the higher the score, the more organ dysfunction/failure is present. A score of 7 or less indicates a probable recovery from organ failure while a score of 11 or greater indicates a poor outcome.

### DATA ANALYSIS

Data were entered into and analyzed using the Statistical Package for Social Sciences (SPSS) version 17 for Windows (2009). Descriptive statistics, frequencies, and percentages were computed to describe the sample. Values obtained on the measurements of IAP were reported as means (Ms) with standard deviations (SDs). The distribution of the scores for IAP was evaluated both by means of visualization of a histogram with the normal curve imposed and calculation of the Kolmogorov-Smirnov Test statistic (D). The distribution of the scores was further described by means of the values for skewness and kurtosis. The null hypothesis stated that there would be a significant increase in the mean post-hygiene intra-abdominal pressure as compared to the mean pressure values obtained prior to the hygiene care activities among patients at risk for intra-abdominal hypertension. This hypothesis compares the scores for IAP obtained on a pre- and post-intervention measurement for the same individuals, matched pairs. Therefore, a t-test for the difference between two dependent means was used.

### RESULTS

The study was conducted over a six-month period. A total of 34 patients were included. Patients were screened by the CCU nursing staff per the nurse-driven IAP protocol upon admission to the CCU or the new onset of organ dysfunction or failure. The average daily census was 12 patients, with approximately four admissions per day. The PI would conduct rounds on the patients requiring IAP measurements daily, which included a review of the medical record and a physical assessment of the patient. The PI would then discuss with the patient's nurse and appropriate family members/partners the best time to give the patient a bath. Each patient was used only once in the study.

Fifty-three percent ( $n = 18$ ) of the sample was female, and 47% ( $n = 16$ ) male. Twenty-eight patients (83%) required ventilator support during the study. The mean APACHE II score in this study meant that the patients had approximately a 40% risk of death. The SOFA score indicated probable recovery from organ failure. See Tables 1 and 2 for demographic data and CCU diagnosis.

As the sample curves for MAP & APP were normally distributed, parametric testing was done. Repeated-measures ANOVAs were used to make comparisons between pre, immediate post, and 10 minutes post complete bath measurements. Post hoc testing was carried out for differences between times. As the sample curve of the immediate post-IAP measurements was skewed, nonparametric testing was done. The Friedman statistic was used; when significance was found within the three time points, post hoc testing utilizing the Wilcoxon Signed Rank Tests (using a Bonferroni adjusted alpha value) was carried out. See Table 3 for

means and standard deviations for the 3 measurement time periods.

### MAP

Pre, post, and 10 min MAP was compared using the repeated measures ANOVA to determine mean differences in

**Table 1.** Demographic data

Characteristic	Mean	SD	Range
Age (years)	62.2	17.66	27–92
BMI (kg m <sup>-2</sup> )	30.26	9.5	16.12–55.85
APACHE II	21.3	6.74	8–33
SOFA	7.44	3.98	0–16
IAH risk factors	3.29	1.38	2–7
CCU day	3.9	3.2	1–17

BMI — body mass index; APACHE — Acute Physiology and Chronic Health Evaluation; SOFA — Sequential Organ Failure Assessment Score; IAH — intra-abdominal hypertension

**Table 2.** CCU diagnosis — sample, n = 34

	n	%
Acute respiratory failure	12	35.3
Sepsis	9	26.5
GI bleeding	5	14.7
Ischemic bowel	2	5.9
Small bowel obstruction	2	5.9
Cardiac arrest	2	5.9
Congestive heart failure	1	2.9
Acute kidney failure	1	2.9

CCU — critical care unit

**Table 3.** Measurements taken pre-bath, immediate post-bath and 10 minutes post-bath

Time period	MAP		IAP		APP	
	M	SD	M	SD	M	SD
n = 34						
Pre-bath	73.59	11.4	9.29	4.0	64.29	11.76
Post-bath	79.38	13.75	8.47	4.29	70.91	14.0
10 minute post-bath	75.88	12.49	7.74	4.41	68.15	13.19

M — mean; SD — standard deviations; MAP — mean arterial pressure; IAP — intra-abdominal pressure; APP — abdominal perfusion pressure

**Table 4.** MAP pairwise comparisons

(I)MAP (J)MAP Mean difference	Std. Error (I-J)	Sig. <sup>a</sup>	95% CI for difference <sup>a</sup>	Lower bound	Upper bound
1	2	-5.794*	2.243	0.043	-11.451
	3	-2.294	1.946	0.740	-7.201
2	1	5.794*	2.243	0.043	0.137
	3	3.500	1.803	0.182	-1.047
3	1	2.294	1.946	0.740	-2.613
	2	-3.500	1.803	0.182	-8.047

Based on estimated marginal means; \*the mean difference is significant at the 0.05 level; <sup>a</sup>Adjustment for multiple comparisons: Bonferroni

MAP at those time periods. Post hoc testing was done using the Bonferroni and Tukey HSD tests. There was statistically significant difference between the 3 measurements (Wilks Lambda: Value .824; F 3.42; Hypothesis df 2.0; Error df 32.0; Sig. 0.045; Partial Eta Squared .176). Post hoc testing with the Tukey HSD test found a statistically significant difference between pre and immediate post bath (see Table 4).

### IAP

The Friedman statistic found significance in the IAP measurements (n = 34; Chi-Square = 18.97; df 2; Sig. 0.000). The Wilcoxon signed rank tests found significance between the 10 minute post IAP measurement and the pre-bath IAP measurement, as well as the 10 minute post IAP measurement and the immediate post-bath measurement (Table 5).

### APP

Due to the significant findings in MAP & IAP it was expected that there would be significant findings in APP. Pre, Post, and 10 min APP was compared using the repeated measures ANOVA to determine mean differences in APP at those time periods (Wilks' Lambda: Value 0.789; F 4.27; Hypothesis df 2.0; Error df 32.0; Sig. 0.023). Post hoc testing

**Table 5.** Wilcoxon test statistics<sup>a</sup> for Intra-abdominal pressure

Measurement	Z Score	Significance
Post IAP — Pre-IAP	-1.747 <sup>b</sup>	0.081
10 min IAP — Pre-IAP	-3.511 <sup>b</sup>	0.000
10 min IAP — Post-IAP	-2.975 <sup>b</sup>	0.003

IAP — intra-abdominal pressure; <sup>a</sup>Wilcoxon Signed Ranks Test; <sup>b</sup>based on positive ranks

**Table 6.** APP pairwise comparisons

(I)APP	(J)APP	Mean difference (I-J)	Std. Error	Sig. <sup>a</sup>	95% CI for difference <sup>a</sup>	
					Lower bound	Upper bound
1	2	-6.618*	2.236	0.017	-12.258	-0.978
	3	-3.853	1.924	0.160	-8.705	0.999
2	1	6.618*	2.236	0.017	0.978	12.258
	3	2.765	1.847	0.432	-1.893	7.422
3	1	3.853	1.924	0.160	-0.999	8.705
	2	-2.765	1.847	0.432	-7.422	1.893

APP — abdominal perfusion pressure. Based on estimated marginal means. \*the mean difference is significant at the 0.05 level; <sup>a</sup>adjustment for multiple comparisons: Bonferroni

using the Bonferroni and Tukey HSD tests showed a significance between the pre bath measurement and the immediate post bath measurement (Table 6).

## DISCUSSION

Previous nursing research on the effects of nursing activities on ICP and SVO<sub>2</sub> of neurologic and cardiac patients respectively, found that successive nursing care interventions had deleterious effects on these measurements. The unexpected finding in this study was that the successive procedures in the hygiene activity statistically significantly lowered the IAP, therefore the null hypothesis is rejected. Could nursing activities have a positive effect on the IAP? Although there were statistically significant findings for the MAP, IAP and APP the findings were not clinically significant as all findings were within the normal range.

Several explanations for why the IAP decreased will be postulated. Perhaps the relaxation of the one-minute backrub or the bed bath caused muscular relaxation in the patient. Another reason that the IAP decreased may be the act of mobilizing the patient from one side to another with a 10-minute waiting period. This study may indicate that giving hygiene care to a critically ill patient at risk for IAH is a safe and perhaps therapeutic activity as it relates to IAP. Further study is needed to identify if all components of the hygiene activities in this study caused the IAP to decrease, or if one specific activity was more influential.

## STRENGTHS AND LIMITATIONS

Currently, there are no published nursing studies on the effects of nursing activities on the IAP of patients at risk for IAH. Nurses need to know if their care has a physiological consequences for the patient. This study supports the findings that hygiene care may have a beneficial effect on a patient's elevated intra-abdominal pressure.

The limitations of this study are its small sample size, as well as having been carried out in only one CCU. This will make it difficult to generalize to the CCU population.

## CONCLUSION

The American Association of Critical Care Nurses has identified that the role of the critical care nurse is to provide safe passage to patients and their families when the patient's needs require the expertise of critical care therapeutics [21]. Critical care nurses have modified patient care to meet the patient's needs and the patient's level of activity without always having evidence-based support. Contrary to what has been found in the literature, this study has provided preliminary evidence that the activity of giving hygiene care does not negatively affect the hemodynamic status or the intra-abdominal pressure of a patient at risk for intra-abdominal hypertension. In fact, it may even be a therapeutic intervention to lower intra-abdominal pressures. This study has opened the door for further nursing research to build an evidence-based body of knowledge in managing the patient at risk for intra-abdominal hypertension.

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