MEASURING INTRABLADDER PRESSURE WITH THE HEAD OF THE BED ELEVATED 30°: EVIDENCE TO SUPPORT A CHANGE IN PRACTICE

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Background  A 30° head-of-bed elevation is recommended for most critically ill patients. Measuring intrabladder pressure with the patient in this position is controversial.

Objective  To assess the feasibility of measuring intrabladder pressure with a 30° head-of-bed elevation.

Methods  A prospective, randomized, and experimental study. Patients had intrabladder pressure measured first while positioned supine with a 30° head-of-bed elevation and 25 mL of saline instilled into the bladder and again after the patients were randomly repositioned to supine without any head-of-bed elevation (flat) or with a 30° head-of-bed elevation while supine or in right lateral or left lateral position with either 25, 50, or 200 mL of saline instilled into the patient’s bladder.

Results  Intrabladder pressures measured with the patient in all 3 head-of-bed elevated positions were higher than pressures measured with patients supine and flat after instillation of 25 mL of saline into the bladder, but intrabladder pressure did not differ between the 30° head-of-bed elevated positions and the supine and flat positions when 50 or 200 mL of saline was instilled into the bladder. Two-way analysis of variance showed a significant interaction between volume of saline instilled ($P = .05$), patient’s position ($P = .007$), and bladder instill volume and position interaction ($P = .004$).

Conclusion  It is feasible to measure intrabladder pressure with a 30° head-of-bed elevation, and that position could be an alternative to supine positioning of patients for measurement of intrabladder pressure. (American Journal of Critical Care. 2011;20:e80-e89)
Intra-abdominal pressure is the pressure within the abdominal compartment. Observed intra-abdominal pressure measured in supine hospitalized patients ranges from 0 to 12.5 mm Hg with a mean (SD) of 6.5 (3.3) mm Hg. By consensus, intra-abdominal hypertension is defined as an intra-abdominal pressure that exceeds 12 mm Hg. Increasing intra-abdominal pressure produces alterations in gastrointestinal, renal, cardiovascular, and respiratory physiology and multiple organ failures, which can manifest as oliguria, decreased venous return, and increased airway pressures. The clinical signs of organ failure in 1 or more systems in association with intra-abdominal hypertension are recognized as abdominal compartment syndrome (ACS). Therefore, routine monitoring of intra-abdominal pressure in critically ill patients is recommended to monitor for intra-abdominal hypertension and ACS.

Intra-abdominal pressure is most commonly measured indirectly by using the urinary bladder technique in critically ill patients who are positioned supine and flat. Because most patients in the intensive care unit (ICU) assume positions with some degree of head-of-bed elevation (HOBE) for routine care, positioning the patient supine and flat 1 to several times a day solely for the purpose of measuring intrabladder pressure (IBP) increases nurses’ workload and may increase the risk of equipment dislodgment and discomfort for the patient. Use of the supine position in patients receiving mechanical ventilation increases the risk of aspiration pneumonia developing. To decrease the occurrence of ventilator-associated pneumonia, the Institute for Healthcare Improvement developed the ventilator bundle with 1 of the 4 components being some degree of HOBE. A number of ICUs have adopted the recommendations of the Institute for Healthcare Improvement as well as the recommendations of the Healthcare Infection Control Practices Advisory Committee of the Centers for Disease Control, the Ventilator-Associated Pneumonia Guidelines Committee and the Canadian Critical Care Trials Group, and the Association of Medical Microbiology and Infectious Disease Canada Guidelines Committee.

In addition, the recommendations of the Canadian Critical Care Clinical Practice Guidelines Committee and the American Society for Parenteral and Enteral Nutrition are for use of HOBE for critically ill adult patients who require enteral nutrition. Although these recommendations and guidelines are specific to intubated, ventilator-dependent and enterally fed patients, the 30° HOBE position has become the preferred position for the vast majority of critically ill patients.

Measuring IBP in patients positioned with a 30° HOBE will avoid the pulmonary pitfalls associated with the supine position and will be in compliance with current recommendations for the care of ICU patients. No physiological, technical, or clinical rationale prohibits measurements of IBP with the patient in the 30° HOBE position. Indeed previous studies of hemodynamic measurements that used a technique identical to IBP measurement have shown that measurements taken in positions with HOBE are technically feasible, reliable, and clinically relevant.

One argument used to recommend against a 30° HOBE position to measure IBP is that this position yields higher IBP values than when IBP is measured with the patient in the supine flat position. However, a higher pressure measurement in the 30° HOBE position compared with the supine flat position is not by itself a strong enough reason to prefer one position over another for measuring IBP. Other considerations such as accuracy and reproducibility of the measurement, predictability of outcomes, and safety and convenience for the patient are just as important as the absolute
IBP value in deciding to select one position over another when measuring IBP.

The aim of this study was to assess the feasibility of measuring IBP in positions with a 30° HOBE, which are consistent with current best-practice recommendations for care of ICU patients. Because the requisite volume of saline instilled into the bladder for IBP measurement affects IBP,28,29 IBP measurements were taken after instillation of 1 of 3 different volumes of saline into the patient’s bladder, reflecting the range of previously studied instillation volumes.

Materials and Methods

The study was reviewed and approved by the institutional review board, and signed informed consent was obtained for all patients.

Selection of Patients

Patients admitted to any of 6 adult ICUs of Allegheny General Hospital, West Penn Allegheny Health System, in Pittsburgh, Pennsylvania, were screened to participate in the study regardless of the patient’s sex, race, diagnosis, or hospital treatment. Inclusion criteria were age at least 18 years and a clinical need for a urinary bladder drainage catheter as determined by the attending physician. Patients were excluded from the study if they were unable to assume any of the 30° HOBE body positions or if they had a neurogenic bladder, a bladder tumor, or a perforation that would potentially influence the muscular tone of the bladder or if they had hematuria, which would potentially alter the measurement techniques.

Study Design

The study was prospective, randomized, and experimental. After informed consent was obtained, participants were positioned supine with a 30° HOBE and an IBP measurement was taken with 25 mL of saline instilled into the patient’s bladder (initial study position). Participants were then randomized to have a second IBP measurement taken in 1 of 12 possible combinations of 4 body positions and 3 volumes of instilled saline. The 4 randomized positions were supine and flat with a 0° HOBE (S), supine with a 30° HOBE (S-30), right lateral with a 30° HOBE (RL-30), and left lateral with a 30° HOBE (LL-30). The 3 randomized volumes of saline instilled were 25 mL, 50 mL, and 200 mL.

The positions and instillation volumes chosen for the study were based on clinical relevance, research interest, and prior research data. The S position was chosen because it is the traditional position used to measure IBP and the position recommended by the American Association of Critical-Care Nurses (AACN)30 and the World Society of the Abdominal Compartment Syndrome (WSACS)13. The 30° HOBE position was chosen because it is the recommended position for the prevention of pneumonia in patients who require mechanical ventilation by the Centers for Disease Control17 and the Canadian Critical Care Trails Group33 and is the position recommended in the ventilator bundle developed by the Institute for Healthcare Improvement15 to prevent ventilator-associated pneumonia regardless of concomitant administration of enteral nutrition26,27 and is of clinical nursing relevance.

The RL-30 and LL-30 positions were chosen because they represent alternative positions recommended to prevent complications of bed rest encountered in intensive care such as pressure ulcers.36 A 45° angled wedge positioning pillow (Hausmann Industries Inc, Northvale, New Jersey) was used to support the patient’s back while in the lateral positions. The 25- and 50-mL instillation volumes were chosen to represent the recommendations of WSACS34 and of AACN,30 respectively, and a 200-mL volume was chosen to represent the larger instillation volume previously used in research studies.35,34

The randomization scheme was prepared by the statistician and delivered to the principal investigator in sealed envelopes that were opened only after signed informed consent was obtained. Patients participated only once per ICU stay. All measurements were taken by the principal investigator (M.H.S.). Once all measurements were obtained, the patients were positioned in the most appropriate and comfortable position on the basis of their medical condition and wishes.

IBP Measurement

IBP was measured by the method of Kron et al35 with modifications as described.30

Statistics

Data were analyzed by using SPSS statistical software (SPSS-15 SPSS Inc, Chicago, Illinois) and are presented as mean (SD). Normally distributed data were analyzed by using a 1-way or 2-way analysis of variance with Neuman-Kuels test for post hoc comparisons. Data that were not normally distributed were analyzed by using Kruskal-Wallis test with Dunn post hoc analysis or the Wilcoxon signed rank test. IBP measured in the initial study conditions and compared with the conditions rec-
ommended by the AACN and the WSACS were analyzed by means of a paired $t$ test.

**Results**

**Description of Study Population**

Between April 2007 and December 2007, 280 adult patients were screened to participate. Sixty-two (22.1%) declined to participate after a detailed explanation of the study was given. Fifty-nine subjects (21.1%) did not meet inclusion criteria; some were less than 18 years of age and others had anuria, hematuria, or neurogenic bladder. Eighteen patients (6.4%) were unable to participate for other reasons, for example, the urinary bladder catheter had been removed or orders for transfer from the ICU were written and adequate time to complete the study could not be guaranteed. Seventeen patients (6.1%) were unable to give informed consent because of sedation, and a surrogate decision maker was not available to give consent. Finally, 3 patients’ families (1.1%) declined participation, and 1 patient (0.4%) was not enrolled for an unknown reason. The remaining 120 subjects (42.9%) agreed to participate in the study and were enrolled after a detailed explanation of the study was provided by the principal investigator and a signed written informed consent was obtained.

Participants were from 18 to 93 years old, with a mean (SD) age of 63.5 (17.1) years. Sixty-six participants (55.0%) were male, and 111 (92.5%) were white. Body mass index (calculated as weight in kilograms divided by height in meters squared) ranged from 15.8 to 54 with a mean (SD) of 29.0 (7.3). The length of stay in the ICU before IBP measurement was from 1 to 50 days, with a mean (SD) of 4.7 (6.8) days. Thirty-eight patients (31.7%) had IBP measured on the first day of admission, 56 (46.7%) within 5 days of admission, and the remaining 26 (21.7%) more than 5 days after admission. A 1-way analysis of variance showed no significant difference in length of stay among the 12 groups, but significant differences were observed for age ($F = 2.5$, $R^2 = 0.2, P = .007$) and body mass index ($F = 2.5$, $R^2 = 0.2, P = .007$). Subjects randomized to the supine 30º HOBE position with 25 mL of saline instilled (see Figure, group 2) were a mean (SD) of 75.8 (6.8) years old and differed in age from the subjects randomized to the supine 0º HOBE position with 50 mL of saline instilled (see Figure, group 5) mean (SD) 51.8 (15.5) years, $P = .05$). Subjects randomized to the RL-30º HOBE position with 50 mL of saline instilled (see Figure, group 7) had a mean (SD) for body mass index of 35.5 (9.3) and differed from subjects randomized to the RL-30º HOBE position with 200 mL of saline instilled (see Figure, group 11), who had a mean (SD) body mass index of 23.8 (3.2) ($P = .01$). All other paired comparisons were not significant.

Forty-eight patients (40.0%) were recruited from the trauma unit, 25 (20.8%) from 2 neurosurgical ICUs, 18 (15.0%) from the medical ICU, 15 (12.5%) from the coronary care unit, and 14 (11.7%) from the surgical ICU. Eight patients (6.7%) were receiving mechanical ventilation, and 5 others (4.2%) were treated with biphasic intermittent positive airway pressure. Twenty-five patients (20.8%) were in negative fluid balance, ranging from -7661 to -73 mL, and 95 patients (79.2%) were in positive fluid balance, ranging from 1 to 35497 mL.

**IBP Measurements in the Initial Study Position**

The IBP measured in the S-30 position with 25 mL of saline instilled yielded values ranging from 1 to 44 mm Hg with a mean (SD) of 11.6 (5.9) mm Hg. One hundred eighteen patients had values between 1 and 25 mm Hg, and 2 patients had values greater than 25 mm Hg. Fifty-three participants (44.2%) had values of 12 mm Hg or greater.

**IBP Measurements in the Randomized Study Position**

One patient randomized to the supine position with 200 mL of saline instilled was unable to assume the position because of respiratory distress and did not complete the study. The IBP measurements in the initial study position and after randomization for each individual patient according to randomization group are shown in the Figure, and the mean (SD) for IBP for each randomized group is shown in the Table. The IBP measured in patients randomized to the 3 different 30º HOBE positions with 25 or 50 mL of saline instilled yielded results within the range of values previously reported in critically ill patients who had IBP measured in the supine position with 25 or 50 mL of saline instilled. The 200-mL instillation volume also yielded measurements in the expected range but occasionally produced very high values (>40 mm Hg), and a few participants complained of the urge to urinate. As a result, the absolute values and the inter-
measured with the patients in the LL-30 position were similar for the 25- and 50-mL instilled volumes (see Table). One-way analysis of variance showed a significant volume effect for each body position. Post hoc analysis via the Dunn comparison test showed that the IBP measurements obtained with 200 mL of saline instilled into the patient’s bladder were sig-

Figure Paired intrabladder pressure (IBP) measurements for all patients (n=119). The left column of each graph is the IBP measured with the patient in the initial study position (supine with a 30° head-of-bed elevation [HOBE] with 25 mL of saline instilled into bladder) and each measurement is represented by a solid black square. The right column of each graph is the IBP measured with the patient in the randomized condition (one of 12 possible combinations of 4 body positions: supine flat [S], supine with a 30° HOBE [S-30], right lateral with a 30° HOBE [RL-30], left lateral with a 30° HOBE [LL-30] and 3 volumes of saline instilled into the bladder: 25, 50 and 200 mL). All groups had 10 patients, except for group 9, which had 9. Position is represented by shapes: downward-pointing triangle for supine and flat (S), upward-pointing triangle for S-30, diamond for RL-30, and circle for LL-30. The volume of saline instilled into the bladder is represented by color: red for 25 mL, yellow for 50 mL, and blue for 200 mL. The scale for IBP (y axis) for the graphs depicting the 200-mL instilled volume (groups 9-12) differs from the scale for the graphs depicting the 25-mL (groups 1-4) and 50-mL (groups 5-8) volumes of saline instilled into the bladder.

patient variability of IBP with 200 mL of saline instilled were higher than for the 25- and 50-mL instillation volumes. For the supine and the RL-30 positions, IBP progressively increased as the volume of saline instilled increased. However, for the S-30, IBP was higher when measured with 25 mL rather than 50 mL of saline instilled, whereas the IBP values measured with the patients in the LL-30 position were similar for the 25- and 50-mL instilled volumes (see Table). One-way analysis of variance showed a significant volume effect for each body position. Post hoc analysis via the Dunn comparison test showed that the IBP measurements obtained with 200 mL of saline instilled into the patient’s bladder were sig-
significantly different from the measurements obtained after instillation of 25 and 50 mL for each body position, but IBP did not differ significantly when measured with 25 vs 50 mL of saline instilled, regardless of position.

One-way analysis of variance demonstrated a significant position effect with the 25- and 50-mL instilled volumes but not with the 200-mL volume. The variability in IBP within the 200-mL BIV group was too great to appreciate any significance related to position. Post hoc Newman-Keuls comparison test showed a significant difference between the supine and all three 30° HOBE positions with 25 mL of saline instilled (P<.01 for all 3 comparisons). For the 50-mL instillation volume, the only significant difference was between the S-30 and RL-30 position (P<.05). For the 200-mL volume, no significant differences were found between positions (P>.05).

To determine if body position and volume of saline instilled are independent determinants of IBP, we performed a 2-way analysis of variance. Because the 4 groups who had IBP measurements taken with 200 mL of saline instilled exhibited massive inter-patient variability relative to the values taken with 25 or 50 mL of saline instilled, model criteria were not met and the data from those 40 patients were omitted from this analysis. The 8 remaining groups (80 patients) were found to have similar variability by using a Brown-Forsythe test and therefore were included in the analysis. Statistical significance was found for both position (P = .007), and volume of saline instilled (P = .05) as well as the interaction of position and volume of saline instilled (P = .004).

**Comparison of AACN and WSACS Recommendations for IBP Measurements**

To further explore the relationship between body position and volume of saline instilled and IBP measurements, patients randomized to the 2 groups that reflected the current recommendations of the AACN and WSACS for IBP measurement were compared with the initial study position (S-30 with 25 mL of saline instilled). The mean of the differences between the initial study position and that recommended by the AACN (ie, supine with 50 mL of saline instilled) was 0.9 mm Hg (95% confidence interval, -2.5 to 4.3, t = 0.6, P = .25; see Figure, group 5). The mean of the differences between the initial study position and that of the WSACS (ie, supine with 25 mL of saline instilled) was 5.2 mm Hg (95% confidence interval, 3.9 to 6.4, t = 9.8, P = .002; see Figure, group 1).

**Discussion**

The definition of intra-abdominal pressure and ACS is based on IBP measurement obtained with

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a Positions: supine and flat, supine with head of bed elevated 30° (S-30), right lateral with head of bed elevated 30° (RL-30), left lateral with head of bed elevated 30° (LL-30).

b P<.01 compared with patients who were supine and had 25 mL saline instilled into the bladder.

c P<.05 compared with patients in the S-30 group who had 50 mL of saline instilled into the bladder.

d P<.05 compared with patients in the same position who had 25 and 50 mL saline instilled into the bladder.

Patients who are unable to assume this position either forgo IBP measurement or are measured supine with some degree of HOBE, but the interpretation of the results is difficult because the degree of HOBE lacks standardization. Furthermore, positioning a patient supine from a more comfortable HOBE position solely for the purpose of measuring IBP places the patient at risk for aspiration pneumonia developing, increases the risk of equipment dislodgment, is inconvenient, and increases the nurse’s workload. Measuring IBP in a position that is rarely used by nurses when caring for critically ill patients truly does not reflect IBP when the head of the bed is elevated, and the IBP taken when the patient is lying supine for a few minutes does not reflect the abdominal pressure when the head of the bed is elevated. Would it not make more sense to measure IBP with the patient in a safer, more comfortable and widely used position rather than in a position that is rarely used?

The advantages of measuring IBP with the patient supine are standardization, familiarity, and the current universal acceptance of the definitions of intra-abdominal pressure and ACS. The present study demonstrates that it is feasible to measure IBP with a 30° HOBE and to obtain results with similar inter-patient variability and absolute IBP values similar to values obtained with patients positioned supine. The mean values of the IBP measurements obtained in the HOBE positions are within the range of values obtained in previous studies that have measured IBP in mixed ICU populations with patients supine and 50 mL of saline instilled. Furthermore, when
50 mL of saline was instilled in the patient’s bladder in the present study, the values obtained with patients supine did not differ significantly from the values obtained in any of the study positions with a 30° HOBE (see Table).

The experimental design used in the present study to a major extent reflects contemporary nursing practice. That is, IBP was first measured in the S-30 position and then patients were moved to the randomized positions. Transition from the S-30 position to supine flat resulted in a mean decrease of 5.2 mm Hg when 25 mL of saline was instilled (see Figure, group 1). This finding is consistent with other studies\textsuperscript{25-27} that have shown increases of 4 to 6 mm Hg when patients were moved in the opposite direction, that is, from supine to 30° HOBE positions. The higher IBP values in HOBE positions are to be expected because of the tension of the abdominal wall musculature and the gravitational effects of the abdominal viscera on the bladder.\textsuperscript{38,39}

Therefore, the difference in absolute IBP values noted in HOBE positions is due to the inherent physiological properties of the abdominal compartment and reflects the sensitivity of IBP to detect changes in intra-abdominal pressure with position changes and should not be construed as a reason to avoid HOBE positions when measuring IBP in critically ill patients.

**Position**

In this study, we generated a large database of IBP measurements taken by a single nurse when ICU patients were in the S-30 position, which is of clinical importance because this position is the most common position assumed by critically ill patients. Furthermore, S-30 is the position recommended by critical care experts on the basis of evidence obtained in ICU and reflects current practice guidelines and consensus standards published by professional organizations to prevent ventilator-associated pneumonia and aspiration pneumonia in critically ill patients.\textsuperscript{15,17,18,20,21}

When the present study was designed, no report of a study that used the S-30 position had been published. Since then, 3 studies\textsuperscript{25-27} have been reported that show data obtained with patients in this position. In all 3 studies, researchers found that the mean IBP is higher when measured with the patient in a 30° HOBE position than with the patient supine. A major difference between the present study and the previous studies assessing the effect of HOBE on IBP is the position and leveling of the pressure transducer at the time of measurement. Vasquez et al\textsuperscript{26} and others did not describe the anatomic landmark used to level the transducer. McBeth et al\textsuperscript{25} and Cheatham et al\textsuperscript{27} leveled the transducer at the intersection of the iliac crest and the midaxillary line, and in this study the transducer was leveled at the symphysis pubis. In addition, McBeth et al\textsuperscript{25} and Vasquez et al\textsuperscript{26} did not relevel the transducer after each position change. Conversely, in the study by Cheatham et al\textsuperscript{27} and in the present study, the pressure transducer was re leveled and rezeroed with each position change. These differences in experimental design are important because elevating the head of the bed may change the relationship of the transducer to the anatomic reference landmark for zeroing and could alter the IBP measurement.

Results of the present study add to the knowledge regarding IBP measurement in ICU patients because this study included an evaluation of 2 lateral positions with a 30° HOBE that had not received adequate attention in earlier studies. These lateral positions were chosen for investigation because after the S-30 position they are the most common positions assumed by critically ill patients and these positions are recommended to prevent the complications of immobility such as pressure ulcers.\textsuperscript{32,40}
The RL-30 and LL-30 positions yielded higher values than did the supine position when 25 mL of saline was instilled into the patient’s bladder but not when 50 mL of saline was instilled (see Figure and Table). Interestingly, the LL-30 position was less sensitive to the volume of saline instilled than all other positions studied. Finally, IBP did not differ significantly between the RL-30 and LL-30, regardless of the volume of saline instilled. As of this writing, researchers in only 1 other study\textsuperscript{41} have reported IBP data when patients were in lateral positions. De Keulenaer et al\textsuperscript{41} measured IBP in 10 ICU patients in a lateral position with no HOBE and then again immediately after the patients were positioned supine. In that study, the measurements were taken 3 times in a single day: morning, afternoon, and evening. As in the present study, De Keulenaer et al\textsuperscript{41} found that IBP measured with patients in the lateral positions with 20 mL of saline instilled was higher than IBP measured with patients supine and that IBP measurements did not differ between the right and left lateral positions.

**Volume**

The independent effect of the volume of saline instilled noted in this study is in agreement with results of 2 studies\textsuperscript{26,42} of the effect of volume of saline instilled on IBP measurements but differed from previous studies because the effect of saline...
volume instilled was assessed with patients in positions other than supine. The present study demonstrated that regardless of patients’ position, instillation of 25, 50 and 200 mL of saline yielded IBP measurements in a range that was clinically expected (see Figure). However, instillation of 200 mL of saline was associated with larger interpatient variability and produced a higher mean IBP value than did instillation of 25 or 50 mL of saline. Furthermore, IBP measurements did not differ significantly when 25 vs 50 mL of saline was instilled. These results are consistent with results of previously reported studies that showed very little differences in IBP when less than 150 mL of saline was instilled. The high variability in IBP observed in selected patients in the present study when 200 mL of saline was used (see Figure, groups 9-12) is most likely due to a lower bladder compliance and/or high residual bladder volume at the start of the study. Thus, to reduce variability in IBP measurements between patients, high volumes of saline should not be instilled. Based on these considerations, instillation of either 25 or 50 mL of saline appears to be appropriate for IBP measurement, supporting the recommendations of the WSACS and the AACN, respectively.

**Position and Volume Interaction**

An important finding of the present study is that both position of the patient and volume of saline instilled at the time of IBP measurement independently affect IBP, but of greater interest is the identification of an interaction between patients’ position and volume of saline instilled that was not previously recognized. This observation was made possible because of the unique study design that allowed these variables to be investigated simultaneously and interactively. By instilling 3 different volumes of saline into the bladder with patients in 4 different positions, we are able to confirm the effect of volume of saline instilled on IBP with patients supine, but additionally found that the effect of volume of saline instilled on IBP is not as pronounced when the head of the patient’s bed is elevated.

These findings clearly illustrate the volume-position interaction and show that either position or volume of saline instilled can affect IBP measurement and further illustrate the need for both accurate positioning of patients and instillation of a consistent volume of saline, both of which are paramount in obtaining interpretable IBP measurements. These findings also highlight the need for all investigators to clearly define the position and the volume of saline instilled into the patient’s bladder when reporting IBP measurements.

**Clinical Implications and Future Research**

The AACN and the WSACS recommend that IBP be measured with patients supine only, but neither of these organizations has provided evidence to support this recommendation. To provide such validation, studies must be conducted where intra-abdominal pressure is measured directly in patients by placement of intraperitoneal catheters. These techniques are not standard practices in the ICU, and their use would significantly increase the risk to patients and cannot be ethically justified. The lack of direct measurement of intra-abdominal pressure is a limitation of the present study, as with all other clinical studies assessing the effects of the volume of saline instilled into the patient’s bladder and position on IBP.

The present study demonstrated that IBP measured with patients in 3 positions with 30° HOBE yielded results that are within the expected range of measurements obtained with patients supine. Furthermore, our results indicate that repositioning patients from the S-30 to the supine position solely to measure IBP yields IBP values that are significantly lower, by approximately 5.2 mm Hg (see Figure, group 1). No significant changes in IBP occurred when the patients were repositioned from the S-30 to LL-30 or RL-30 position. In addition, the supine position is more sensitive to changes in the volume of saline instilled than are the other HOBE positions studied, as shown by progressive increases in IBP values as the volume of saline instilled was increased. In contrast, when measurements were made with patients in the S-30 and the LL-30 positions, progressive increases in IBP were not observed (see Table).

Finally, although this point was not directly assessed in this study, keeping patients in the S-30 position for IBP measurement is theoretically expected to decrease nurses’ workload, reduce the risk of aspiration pneumonia developing and equipment being dislodged, and indirectly increase patients’ comfort and safety. If current guidelines are followed for prevention of ventilator-associated pneumonia and aspiration pneumonia related to enteral nutrition, most patients are expected to have a 30° HOBE or greater while positioned supine or lateral and would need to be repositioned supine and flat for the sole
purpose of measuring IBP. After IBP measurement, patients would be repositioned to an HOBE of at least 30°, and it is unclear what the value is of measuring IBP with patients in a position that is rarely assumed in the ICU. When the technical aspects of IBP measurement such as interobserver and intraobserver variability are considered in tandem with nurses’ workload and patients’ safety and comfort, the S-30 appears to be a more desirable position to measure IBP than the supine position.

Serious consideration needs to be given to nursing research that is devoted to developing protocols where the S-30 becomes the standard position for measuring IBP or at least an acceptable alternative standard position for patients who are unable to assume the supine and flat position. Because the diagnosis and prognosis of intra-abdominal hypertension and ACS are all based on IBP values measured with patients supine and flat, accepting the S-30 position for IBP measurement will require more research to redefine the intra-abdominal pressure value that correlates with intra-abdominal hypertension and ACS, thereby requiring a revision of the definitions of intra-abdominal hypertension and ACS.

Further studies are needed that compare the positions of supine and flat and S-30 with outcome variables rather than the absolute differences in IBP, which has been the only outcome variable assessed. For instance, it would be of interest to determine if IBP when measured in the S-30 position is associated with less nursing time, less disruption of care, and better quality of life for critically ill patients as compared with the supine position. In addition, it would be important to investigate the IBP that defines intra-abdominal hypertension in the 30° HOBE position and if this position correlates better with other important outcomes such as mortality and need for abdominal decompression than does the supine flat position.

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23. Groom L, Frisch SR, Elliott M. Reproducibility and accuracy


