

# Effect of Braden Score-Guided Targeted Nursing Interventions on Preventing Intraoperative Pressure Ulcers in Aortic Dissection Surgery

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**Objective:** This prospective randomized controlled study aimed to evaluate the effect of Braden score-guided targeted nursing interventions on preventing intraoperative pressure ulcers in aortic dissection (AD) surgery.

**Methods:** A total of 120 patients who underwent AD surgery at the hospital between December 2023 and December 2024 were selected and randomly assigned to either the study group or the control group, with 60 patients in each group. The control group received routine nursing care, while the study group received targeted nursing interventions guided by the Braden score in addition to routine care. Statistical analyses were conducted to compare the results between the two groups.

**Results:** Following the implementation of targeted nursing interventions guided by the Braden score, the total nursing behavior scores for pressure ulcer prevention ( $95.67 \pm 3.41$  vs  $83.95 \pm 5.16$ ), including all individual dimension scores (preoperative care:  $56.71 \pm 2.43$  vs  $48.53 \pm 4.91$ ; intraoperative care:  $22.39 \pm 1.68$  vs  $17.64 \pm 2.75$ ; postoperative care:  $13.65 \pm 2.49$  vs  $10.48 \pm 2.51$ ), were significantly higher in the study group compared to the control group ( $P < 0.05$ ). The incidence of intraoperative pressure ulcers was notably lower in the study group (2.5%) than in the control group (17.5%) ( $P < 0.05$ ). Additionally, the pressure ulcer area was significantly smaller ( $2.11 \pm 0.36$  vs  $4.98 \pm 1.14$  cm<sup>2</sup>), and the duration of pressure ulcers was markedly shorter in the study group compared to the control group ( $2.73 \pm 1.24$  vs  $7.86 \pm 1.65$  days) ( $P < 0.05$ ). Nursing satisfaction levels were also significantly higher in the study group (97.5% vs 82.5%) ( $P < 0.05$ ).

**Conclusion:** Targeted nursing interventions guided by the Braden score demonstrated effectiveness in identifying risks of intraoperative pressure ulcers. The designed interventions enhanced the quality of nursing care in the operating room, reduced the incidence of pressure ulcers, and improved patient satisfaction.

**Keywords:** aortic dissection surgery, effect observation, intraoperative pressure ulcer, targeted nursing, the Braden score

## Background

Pressure ulcers develop due to prolonged pressure on specific areas of the body, leading to impaired blood circulation, tissue ischemia, hypoxia, and nutrient deficiencies, which ultimately result in the loss of normal skin function and tissue damage.<sup>1</sup> Intraoperative pressure ulcers typically develop within six days post-surgery, with most cases occurring one to three days postoperatively.<sup>2</sup> The incidence of perioperative pressure ulcers in hospitals ranges from 14.3% to 23.9%. The formation of pressure ulcers hinders patient recovery and rehabilitation, negatively impacts physical and mental well-being, and imposes a significant financial burden.<sup>3</sup>

Patients undergoing aortic dissection (AD) surgery are particularly prone to pressure ulcers due to extended operating times, tissue damage, extracorporeal circulation adjustments, prolonged postoperative bed rest (which reduces muscle strength), and the necessity for assisted position changes.<sup>4,5</sup> Moreover, nutritional support for the prevention and

treatment of pressure ulcers is crucial in healthy aging. Nutritional intervention for patients with preoperative NRS2002 score  $\geq 3$  can reduce the risk of pressure ulcers by 30%. However, research indicates that operating room nurses often lack awareness of pressure ulcer prevention, and routine risk assessments are prone to omissions or errors. Early risk screening and position management are emphasized in community nursing, while hospital environments place greater emphasis on intraoperative temperature maintenance and instrument decompression. The Braden score provides a systematic and reliable tool for evaluating pressure ulcer risk, improving nursing assessment skills and guiding the formulation of effective care plans.<sup>6,7</sup> For example, Cai et al utilized the NOSIE and Braden Pressure Ulcer Risk Assessment Scale to effectively assess and address pressure ulcer risks in psychiatric inpatients, successfully reducing their incidence.<sup>8</sup> Building on these findings, the present study evaluated the application of targeted nursing interventions guided by the Braden score for patients undergoing AD surgery. This study aims to answer the following question: 1) Can the Braden score accurately identify the risk of pressure ulcers in patients undergoing aortic dissection surgery? 2) Can targeted nursing interventions reduce the incidence of intraoperative pressure ulcers?

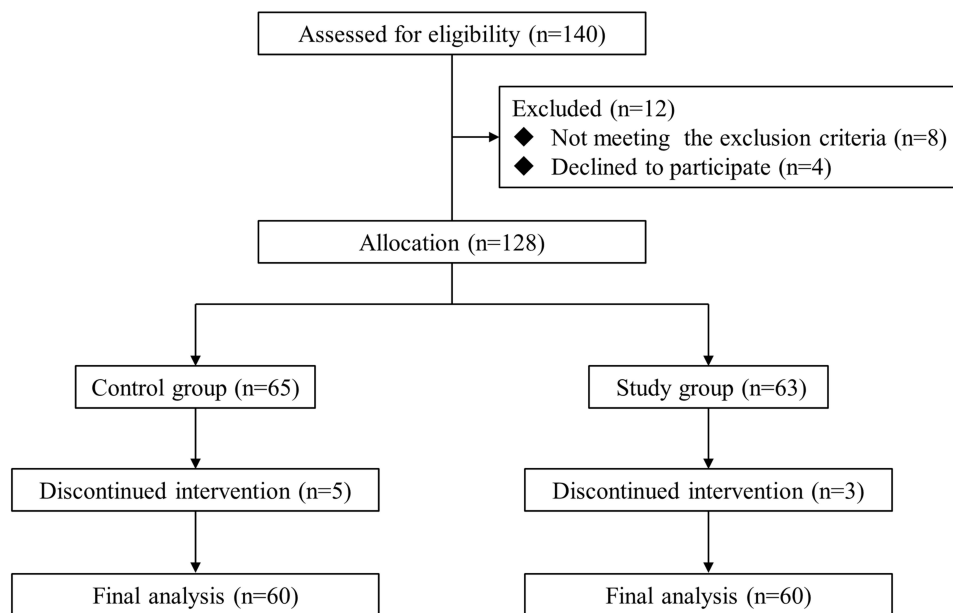
## Study Subjects and Methods

### Study Subjects

This prospective randomized controlled trial (RCT) finally analyzed the data of 120 patients who underwent AD surgery at the hospital between February 2023 and October 2023, with 60 patients in each group. The flow chart is shown in Figure 1.

The inclusion criteria were as follows: 1) age  $\geq 18$  years; 2) no history of pressure ulcers prior to surgery; 3) adequate cognitive awareness and proficient verbal communication skills; 4) provision of signed informed consent by patients and their families after being informed about the study.

The exclusion criteria were as follows: 1) presence of impaired skin integrity, severe organ dysfunction (eg, pulmonary, hepatic, renal), or chronic diseases; 2) diagnosis of psychiatric disorders or cognitive dysfunction.



**Figure 1** The flow chart.

## Study Methods

### Routine Care

The control group received routine care, which included health education, preoperative visits, clothing changes, psychological support, and traditional pressure ulcer prevention measures. The study group received targeted nursing interventions based on the Braden score, in addition to routine care.

### Targeted Nursing Based on Braden Score

An Intraoperative Pressure Ulcer Prevention and Management Team was established, led by the head nurse and comprising operating room and ward nurses. The team received systematic training on pressure ulcer knowledge, Braden scoring, body positioning, surgical procedures, and surgical collaboration to improve risk awareness and enhance prevention and treatment capabilities. Regular meetings were conducted, incorporating tools such as fishbone diagrams, brainstorming sessions, and PDCA (Plan-Do-Check-Act) management to identify causes, risk factors, and targeted measures for preventing intraoperative pressure ulcers in patients undergoing AD surgery.<sup>9</sup> Nurses were encouraged to discuss common clinical issues and share personal experiences. The head nurse supervised preoperative pressure ulcer risk assessments and targeted nursing interventions, documented identified issues, and continuously monitored the recovery status of patients with pressure ulcers. Additionally, the team held regular meetings in which members presented reports on pressure ulcer cases, analyzed underlying causes, and highlighted any issues encountered. This facilitated collective analysis and the development of response strategies. The specific nursing interventions implemented are detailed as follows:

#### Preoperative Pressure Ulcer Assessment

Braden Scale demonstrated Cronbach's  $\alpha=0.85$  and test-retest reliability  $r=0.91$ , indicating the scientific validity and reliability of the rating scale. The risk of developing pressure ulcers were assessed preoperatively using the Braden score, which evaluates six parameters: sensory perception of the skin, moisture, activity level, mobility, food intake, and the presence of friction and shear. Each parameter was scored on a scale from 1 to 4. A total score greater than 18 indicated no risk, scores between 15 and 18 indicated low risk, scores between 13 and 14 indicated moderate risk, and scores of 12 or lower indicated high risk ([Supplementary Table](#)).<sup>10,11</sup> For patients with a Braden score of 12 or less, targeted nursing interventions were implemented. If the patient remained at risk despite these interventions, an unavoidable pressure ulcer reporting form was completed and submitted to the nursing department. The department subsequently conducted a centralized consultation to determine a nursing diagnosis, plan interventions, and provide guidance for nursing care.

#### Targeted Nursing Measures

① Psychological Preparation: During the preoperative visit, patients were provided with clear, jargon-free explanations regarding surgical positioning, discomfort, the mechanism of pressure ulcer formation, associated risks, and prevention strategies. Psychological assessments were conducted, and verbal encouragement alongside gentle physical touch was used to provide reassurance. For patients experiencing fear of death, circulating nurses adopted a supportive approach by firmly holding the patient's forearm and offering comforting words, such as, "Please trust that we will do our utmost to help you", to foster mental preparedness. ② Thermal Regulation for Microcirculation Protection: To prevent intraoperative hypothermia, which can impair skin microcirculation and increase pressure ulcer rates, the operating room temperature was maintained between 21 to 25 °C. Blankets and sterile drapes were used to retain body heat, and a hollow cotton blanket, pre-warmed to 37 °C in a warming cabinet for 10 minutes, was gently placed over the patient. Intravenous fluids and blood products were also warmed to 37 °C prior to administration. ③ Optimal Positioning and Pressure Relief: During intraoperative positioning, proper positioning techniques were employed to minimize pressure on vulnerable skin areas. A soft pillow was placed between the knees, and a 3D soft foam dressing was used on compressed skin areas. The specification of 3D foam dressing was 10cm × 15cm, and the thickness of Hydrogel pad was 2cm. Dressings were carefully positioned to avoid overlapping or reapplication. A water blanket was used in combination with a large hydrogel pad placed underneath the patient, extending from the upper scapula to the sacrococcygeal region. Bed sheets and cloth pads were kept smooth and dry. Movements during the procedure were performed gently to prevent skin trauma from dragging. During extracorporeal circulation rewarming, adjustments were limited to increments of no more than 15 °C. Compressed areas

were massaged to enhance blood circulation. Gradual rewarming was ensured to avoid excessive sweating, which could increase skin humidity and elevate the risk of pressure ulcer formation. ④ Patients at low or no risk for pressure ulcers did not require special treatment but underwent continuous assessment of their overall condition. During surgery, temperature, skin condition, and blood loss was closely monitored, and any abnormalities were promptly reported and addressed. Before the operation, photographs were taken of the skin to document its baseline condition. A detailed handover was provided to ward nurses postoperatively, including any observations of the patient's skin status. ⑤ For patients at medium risk for pressure ulcers, standard care was enhanced with additional precautions. Positioning and care activities adhered to standard operating procedures, with gentle movements to minimize the risk of skin injury. A pressure-relieving foam pad was placed on the surgical bed, and soft pillows were positioned under both feet to elevate the heels. Postoperatively, skin conditions in compressed areas were closely observed, with Braden scores assessed every 72 hours. ⑥ Patients identified as high risk for pressure ulcers underwent comprehensive care measures. During the preoperative visit, a nutritional risk assessment using the Nutritional Risk Screening (NRS2002) tool was performed.<sup>12</sup> For patients with an NRS score of  $\geq 3$ , a discussion with the anesthesiologist and surgeon was held to determine necessary nutritional support. The unavoidable pressure ulcer reporting form was completed and a nursing consultation was arranged to establish a specialized care plan. Patients and their families were informed of the pressure ulcer risk assessment results, educated on prevention strategies, and actively involved in care. During surgery, blood loss, core temperature, rectal temperature, oral temperature, and skin condition were monitored closely. Adjustments to pressure points and pressure-relieving massages were performed every 2 hours to improve circulation without affecting the procedure. Postoperatively, Braden scores were assessed every 24 hours and any abnormalities, such as redness or swelling in pressure-prone areas were monitored and promptly addressed. ⑦ Comprehensive Documentation and Handover: Post-surgery, a thorough assessment of the patient's skin condition was assessed, starting with the head and trunk and progressing to the upper limbs, buttocks, and lower limbs. For patients who developed pressure ulcers, the location, severity, and size of the ulcers was recorded, and a focused handover was provided to ward nurses and doctors to guide appropriate treatment. ⑧ Type A AD involves damage to the left and right coronary arteries in the aortic sinus, and a bypass is often necessary. Therefore, extensive disinfection of the surgical field was performed, covering the area from the neck to the feet, including the region over the great saphenous vein. The circulating nurse managed the iodine usage, typically limiting it to 1 to 1.5 bottles (500 mL each), and avoided using iodine-soaked cotton balls to prevent seepage beneath the skin. Dry absorbent pads were applied as necessary. ⑨ Post-operative documentation included photographs of key pressure-prone areas, including the sacral region, head, neck, shoulders, posterior auricular, heels, and occipital region.

## Observational Measures

(1) A self-developed nursing behavior scale was used for assessing pressure ulcer prevention practices. This scale compared the preventive nursing behaviors between the study and control groups and included three dimensions: preoperative care (encompassing pressure ulcer risk assessment, health education, communication skills, and material preparation), intraoperative care (covering patient positioning, vital signs monitoring, surgical cooperation, nursing for pressure points, and targeted nursing interventions), and postoperative care (including skin condition assessment, pressure ulcer documentation, patient handover, and follow-up care). The scale consisted of 25 items, each scored on a 4-point Likert scale, with total scores ranging from 25 to 100. Higher scores indicated superior preventive nursing behaviors related to pressure ulcers.

(2) The intraoperative pressure ulcer status of patients in both groups was assessed and compared based on established pressure ulcer classification criteria. This classification consisted of three levels: intact skin, stage I erythema, and stage II inflammatory infiltration.<sup>13</sup> The overall incidence of pressure ulcers, the area of pressure ulcers, and the duration of pressure ulcers were compared between the two groups.

(3) A self-designed nursing satisfaction survey was used to assess and compare patient satisfaction with nursing care between the two groups. The questionnaire included 10 items that evaluated nursing skills, communication attitudes, health education, surgical safety, and nursing effectiveness. Each item was rated on a scale from "very dissatisfied" to "very satisfied", with corresponding scores ranging from 0 to 3 points. The total score ranged from 0 to 30, where a score of less than 10 indicated dissatisfaction, a score between 10 and 24 indicated basic

satisfaction, and a score of 25 or higher indicated high satisfaction. The nursing satisfaction rate was calculated using the formula: (basic satisfaction + high satisfaction) / n × 100%.

## Statistical Methods and Sample Size Calculation

The survey data were analyzed using the latest version of SPSS 22.0 statistical software. Continuous data are presented as means ± standard deviations and analyzed using *t*-tests, while categorical data are expressed as [n(%)] and analyzed using  $\chi^2$ -tests. A  $p < 0.05$  was considered statistically significant. Based on the preliminary pre-test pressure ulcer incidence rate of 20%, setting  $\alpha=0.05$  and  $\beta=0.2$ , the sample size of this study was calculated that each group required 60 cases.

## Results

### Comparison of Baseline Data Between the Two Groups

The study group comprised 46 males and 14 females, aged 20 to 70 years, with a mean age of  $41.38 \pm 7.52$  years. Educational levels in this group were as follows: 34 patients with a junior high school education or below, 17 with a high school or vocational school education, and 9 with a college education or higher. Disease types included 26 cases of Stanford type A, 11 cases of Stanford type B, 8 cases of DeBakey type I, 6 cases of DeBakey type III, 2 cases of intramural hematoma (IMH), and 7 cases of DeBakey type II. The control group comprised 47 males and 13 females, aged 20 to 69 years, with a mean age of  $40.71 \pm 7.49$  years. Educational levels in this group were as follows: 32 patients with a junior high school education or below, 18 with a high school or vocational school education, and 10 with a college education or higher. Disease types included 24 cases of Stanford type A, 12 cases of Stanford type B, 10 cases of DeBakey type I, 8 cases of DeBakey type III, 1 case of IMH, and 5 cases of DeBakey type II. Gender, age, education level, and disease type were comparable between the two groups ( $P > 0.05$ ) (Table 1). This study adheres to the STROBE Statement for observational research.

### Comparison of Pressure Ulcer Prevention Nursing Behaviors Between the Two Groups

Following the implementation of targeted nursing interventions based on the Braden score, the study group demonstrated significantly higher total scores for pressure ulcer prevention nursing behaviors compared to the control group. Scores for

**Table 1** Analysis of General Data for the Two Groups of Patients [ $(\bar{x} \pm s)$ , (n,%)]

Items		Control Group (n=60)	Study Group (n=60)	$\chi^2/t$	P
Gender (male/female)		47/13	46/14	0.015	0.943
Age (year)		$40.71 \pm 7.49$	$41.38 \pm 7.52$	0.018	0.985
Disease types	Stanford type A	24	26	0.058	0.808
	Stanford type B	12	11		
	DeBakey type I	10	8		
	DeBakey type III	8	6		
	Intramural hematoma	1	2		
	DeBakey type II	5	7		
Education level	Primary school	20	20	0.049	0.625
	Junior high school	12	14		
	High School/Technical College	18	17		
	College degree and above	10	9		

**Table 2** Comparison of Nursing Behaviors for Pressure Ulcer Prevention Between the Two Groups

Group	N	Preoperative Care	Intraoperative Care	Postoperative Care	Total score
Study group	60	56.71±2.43	22.39±1.68	13.65±2.49	95.67±3.41
Control group	60	48.53±4.91	17.64±2.75	10.48±2.51	83.95±5.16
t-value		9.443	9.322	5.671	11.985
P-value		0.000	0.000	0.000	0.000

**Table 3** Comparison of Intraoperative Pressure Ulcer Incidence Between the Two Groups (n, %)

Group	N	Intact Skin	Stage I Pressure Ulcer	Stage II Pressure Ulcer	Pressure Ulcer Rates
Study group	60	39(97.5)	1(2.5)	0(0.0)	1(2.5)
Control group	60	33(82.5)	4(10.0)	3(7.5)	7(17.5)
t-value					5.000
P-value					0.025

each dimension were also significantly higher in the study group. These differences were statistically significant ( $P < 0.05$ ), as shown in [Table 2](#).

### Comparison of Intraoperative Pressure Ulcer Rates Between the Two Groups

After intervention, the incidence of intraoperative pressure ulcers was significantly lower in the study group (2.5%) compared to the control group (17.5%) ( $P < 0.05$ ), as shown in [Table 3](#).

### Comparison of Pressure Ulcer Area and Duration of Pressure Ulcers Between the Two Groups

Post intervention, the pressure ulcer area was significantly smaller, and the duration of pressure ulcers was significantly shorter in the study group compared to the control group ( $P < 0.05$ ), as shown in [Table 4](#).

**Table 4** Comparison of Pressure Ulcer Area and Duration Between the Two Groups

Group	N	Pressure Ulcer Area (cm <sup>2</sup> )	Duration of Pressure Ulcers (d)
Study group	60	2.11±0.36	2.73±1.24
Control group	60	4.98±1.14	7.86±1.65
t-value		15.183	15.719
P-value		0.000	0.000

**Table 5** Comparison of Nursing Satisfaction Between the Two Groups (n, %)

Group	N	Dissatisfaction	Basic Satisfaction	High Satisfaction	Overall Satisfaction
Study group	60	1(2.5)	5(12.5)	34(85.0)	39(97.5)
Control group	60	7(17.5)	11(27.5)	22(55.0)	33(82.5)
t-value					5.000
P-value					0.025

## Comparison of Nursing Satisfaction Between the Two Groups

After the implementation of targeted nursing interventions, nursing satisfaction in the study group was significantly higher than that in the control group ( $P < 0.05$ ), as shown in Table 5.

## Discussion

The incidence of intraoperative pressure ulcers is a key indicator of nursing care quality in the operating room. A thorough and professional evaluation of high-risk individuals prior to surgery is essential for effective prevention of pressure ulcers.<sup>14,15</sup> Studies have demonstrated that the development of pressure ulcers is influenced by various factors, including patient age, underlying diseases, nutritional status, surgery type, positioning, surgery duration, and intraoperative temperature.<sup>16,17</sup> Patients undergoing AD surgery are particularly vulnerable to pressure ulcers due to several factors, such as the severity of their condition, inadequate nutritional intake, which predisposes them to deficiencies, the traumatic nature of the surgery, which involves extensive wounds similar to heart transplant surgeries, significant blood loss from AD rupture, prolonged surgical durations (typically 6 to 8 hours, with procedures exceeding 4 hours doubling the risk), prolonged pressure on specific skin areas, temperature fluctuations from extracorporeal circulation, and postoperative incision pain, which can reduce patient compliance with repositioning protocols. Therefore, developing a structured and effective nursing model for early identification of pressure ulcer risks in patients undergoing AD surgery. By integrating targeted preventive interventions based on risk stratification, it is possible to mitigate the incidence of intraoperative pressure ulcers.

Studies have shown that the Braden score is an independent predictor of intraoperative pressure ulcer occurrence in patients.<sup>18</sup> Therefore, it is essential to enhance pressure ulcer risk assessments, address relevant risk factors, and implement proactive preventive measures. In this study, the Braden score was used to assess the risk of pressure ulcers in patients prior to surgery. Based on the results, patients were classified into different risk levels for pressure ulcers, and targeted nursing interventions were applied accordingly. For patients categorized as low or no risk, no specific interventions were employed to optimize the allocation of nursing staff. However, dynamic evaluations were performed to monitor any changes in patient conditions, allowing for timely adjustments to nursing strategies. For patients categorized as moderate to high risk, comprehensive monitoring of blood loss, body temperature, and skin condition was conducted. Given that the incidence of pressure ulcers significantly increases in patients undergoing surgeries lasting more than 2.5 hours, adjustments and massages of pressure points were performed every two hours.<sup>19</sup> Furthermore, a focused handover to ward nurses was implemented following surgery to ensure continuous monitoring of potential pressure ulcer development and progression. Prompt interventions were initiated when abnormal findings were observed. Psychological factors were also considered, as negative emotions can depress immune function, impede wound healing, and exacerbate pressure ulcer risk. Preoperative psychological assessments were conducted to provide information about the surgery and pressure ulcer prevention, and mitigate emotional distress.

Pressure ulcer incidence increases by approximately 20% for every 0.6 °C decrease in intraoperative body temperature due to hypothermia.<sup>20</sup> Therefore, maintaining a stable operating room temperature and monitoring the patient's body temperature throughout surgery are critical. Moreover, pressure-related factors such as vertical pressure, shear force, and friction play a significant role in pressure ulcer development.<sup>21</sup> Proper surgical positioning, use of 3D soft foam dressings on areas of compression, along with regular adjustments and massages to reduce pressure were emphasized. Elevated humidity, which compromises the epidermal barrier and facilitates skin breakdown, was managed by ensuring that the surgical bed and pressure-prone areas remained dry and smooth.

The findings of this study demonstrate that the implementation of targeted nursing interventions based on the Braden score led to significantly higher total scores and scores across all dimensions of nursing behaviors for preventing pressure ulcers in the study group compared to the control group ( $P < 0.05$ ). Additionally, the incidence of intraoperative pressure ulcers was notably lower in the study group (2.5%) compared to the control group (17.5%), with statistical significance ( $P < 0.05$ ). The area of pressure ulcers in the study group was significantly smaller, and the duration of pressure ulcers was notably shorter compared to the control group ( $P < 0.05$ ). Furthermore, nursing satisfaction levels were significantly higher in the study group ( $P < 0.05$ ).

These results indicate that the Braden score is an effective tool for identifying patients at risk for intraoperative pressure ulcers, enabling nursing staff to implement targeted preventive strategies. Such interventions can reduce the incidence of intraoperative pressure ulcers and improve the overall quality of care in the operating room, thereby enhancing patient satisfaction. These findings align with those of Huang Lina, which demonstrated that the Pressure Ulcer Risk Assessment Scale effectively mitigates the risk of pressure ulcers in patients.<sup>22</sup> This approach is beneficial for fostering a positive nurse-patient relationship, enhancing patient comfort during hospitalization, and potentially shortening the length of hospital stays, thus making it a recommended practice.

## Limitations and Recommendations

This study has some limitations. It is a single-centre study and only includes cases from 2023–2024, which may introduce regional and temporal biases. Future multi-centre studies are needed to validate these findings, particularly focusing on differences in intervention outcomes across regions with varying levels of medical care. Currently, follow-up is only up to 72 hours post-surgery, and long-term pressure ulcer healing outcomes have not been assessed. It is recommended that future studies extend follow-up to 14 days postoperatively and incorporate quality of life scores for comprehensive evaluation. However, the positive results of this study suggest that the Braden Scale-guided intervention model can be incorporated into the routine nursing procedures in the operating room, with the establishment of a specialised team comprising operating room nurses, anaesthesiologists, and dietitians. Additionally, for patients with aortic dissection who require prolonged bed rest post-discharge, community nurses can use the Braden Scale for home-based risk screening and guide family members in the use of pressure-relieving mattresses and position-changing techniques. A “hospital-community” data-sharing platform should be established, with weekly uploads of skin condition photos post-surgery to ensure continuity in pressure ulcer prevention management.

## Conclusion

The use of targeted nursing preventive measures based on the Braden score for patients undergoing AD surgery effectively identifies the risk of intraoperative pressure ulcers. These interventions enable operating room nurses to develop and implement appropriate preventive strategies, significantly improving the quality of nursing care, reducing the incidence of intraoperative pressure ulcers, and enhancing patient satisfaction with nursing care. Additionally, the promotion of the Enhanced Recovery After Surgery model is recommended, warranting further clinical exploration and application.

## Abbreviations

AD, aortic dissection; IMH, intramural hematoma; PDCA, Plan-Do-Check-Act.

## Data Sharing Statement

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

## Ethics Approval and Consent to Participate

This study was conducted with approval from the Ethics Committee of Shandong Provincial Third Hospital (KYL-2023072). This study was conducted in accordance with the declaration of Helsinki. Written informed consent was obtained from all participants.

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## Disclosure

The authors declare that they have no competing interests for this work.

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