

The Efficacy of Yanin Bed in the Prevention and Treatment of Pressure Ulcers

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Abstract: **Objectives:** To evaluate the efficacy of pressure ulcer prevention and treatment after the implementation of Yanin bed.

Methods: An uncontrolled clinical trial was studied in patients with Braden score <12 at Suratthani Hospital, Suratthani. The pressure ulcers in the treatment group were in grade 2-4. Yanin beds were implemented to patients in both ulcer group and non-ulcer group. Percentages of prevention and treatment were reported with 95% confidence interval.

Results: Forty-eight patients were included in this study, 21 patients in the prevention group and 27 patients in the treatment group. Yanin bed allowed complete prevention of pressure ulcers during 4-55 days. In the treatment group, ulcer healing was completed in 9 patients [33.3% (95%CI = 32.4-34.2)], improved in 17 patients [63% (95%CI = 62.1-63.9)] and not improved in only 1 patient [3.7% (95%CI = 2.8-4.6)].

Conclusion: The application of Yanin bed, in addition to conventional treatments, is effective in the prevention and treatment of pressure ulcers.

INTRODUCTION

Pressure ulcer is a common and serious problem in bed-ridden patients. The extension and progression of pressure ulcer can cause severe infection and lead to patient's mortality. The acceptable factor for the development of ulcer is direct pressure. Unrelieved pressure above normal end-capillary arterial pressure (32 mmHg) over a bony prominence results in an ulcer.

There are specific groups of patients with the tendency for developing pressure ulcers; those with spinal cord injuries and the elderly. Several strategies

have been implemented for the prevention and treatment of pressure ulcers. Preventive strategies include the recognition of risk factors, decreasing the effects of pressure, improving nutritional status, avoiding excessive bed rest, and preserving the integrity of the skin. Treatment principles include assessing the severity of the wound, reducing pressure, friction and shear forces, optimizing wound care, removing necrotic debris, managing bacterial contamination and correcting nutritional deficits. Despite aggressive measures for the prevention of pressure ulcers, the incidence of pressure ulcers can be reduced to a certain level but not to zero. One of the important

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factors in the prevention and treatment of pressure ulcer is the reduction of tissue pressure below the capillary closing pressure of 32 mmHg. Because of the limitation of frequent turning of the patient (every 2 hours or less), many devices have been developed. Devices can be classified as pressure relieving (consistently reducing interface pressure to less than 32 mmHg) or pressure reducing (pressure less than standard support surface, but not below 32 mmHg). These devices can reduce the incidence and severity of pressure ulcers when compared with standard hospital mattress according to some prospective randomized trials.

With the concept of tissue pressure reduction, we invented Yanin Bed by using all materials and technology in Thailand. This study showed the effectiveness of Yanin Bed in the prevention and treatment of pressure ulcer. The principle of Yanin Bed is pressure alternation. The mattresses were made of solid material instead of soft or malleable material. The bed consists of two parts, fixed and movable parts. When movable part moves upward and downward, the pressure will be alternated between fixed part and movable part.

This study was approved by the ethics committee of Suratthani Hospital. The objectives of the study were 1) to evaluate the effectiveness (percentage of pressure ulcer prevention) in high risk patients (Braden score <12) and 2) to evaluate the outcome of the

patients with pressure ulcers after Yanin Bed was implemented.

MATERIALS AND METHODS

Volunteers for the clinical testing of the bed were selected from patients who cannot move their bodies. All of them could only lie down on the bed and could not change their position. The back, sacral area and heels were monitored during the duration of the trial period. Photographs were taken at regular interval for comparison of the results. The duration of alternation must be less than 30 minutes; before the stage of hyperemia occurred. Less alternation duration resulted in better outcome.

Yanin bed consists of two parts, A and B (Figure 1). Part A is a slated track fixed to the main bed frame. Part B is a slated track which can move independently between the slates of part A. Part B can move upward and downward using a hydraulic jack H (Figure 2). When part B moves to its high position, it can hold the patient's weight and at this point in time the patient's skin does not touch part A. When part B moves to its lowest position, part A can hold the patient's weight and at this point the patient's skin does not touch part B. The bed is controlled by a control board which allowed part B to move up and down every 5 minutes. A pad that fits in a track is made of latex. (Figure 3 & 4)

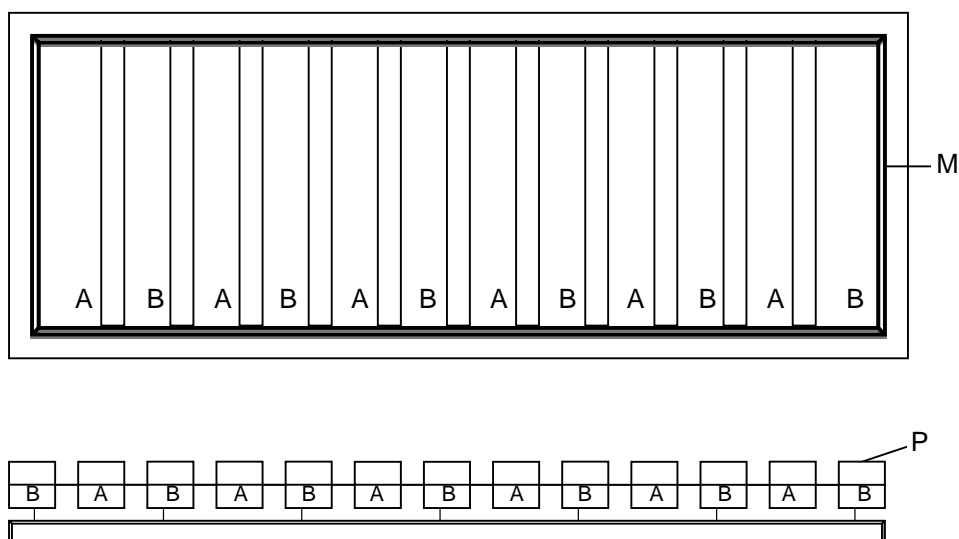


Figure 1 The Yanin bed consists of two parts, A and B. Part A is a slated track fixed to the main bed frame (M). Part B is a slated track moving upward and downward independently between the slates of part A. A pad (P) which fits in a track is made of the latex.

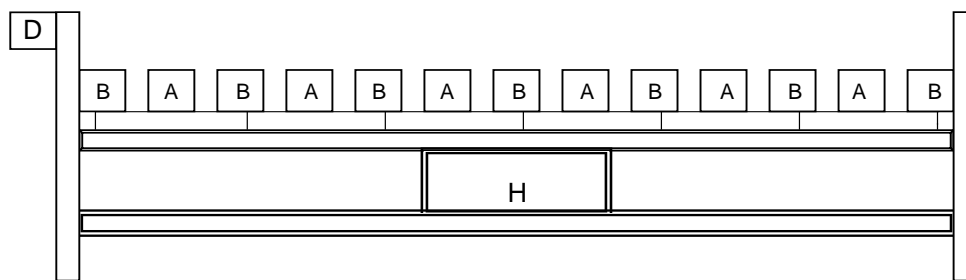


Figure 2 Part B moves upward and downward using hydraulic jack (H). The duration of movement is controlled by control board (D)



Figure 3 When movable parts move to their highest position, it could hold the entire patient's weight.



Figure 4 When movable parts move to their lowest position, fixed part could hold the entire patient's weight.

Inclusion criteria in the selection of patients included 1) patients who could not move their bodies during the study, with age more than 15 years and with Braden score ≤ 12 (Table 1), 2) patients with pressure ulcers of grade 2-4 (Table 2) in the treatment groups and 3) patients who could only lie down on the bed but could not change their position unless necessary procedures such as cleaning the body, wound dressing, or physical therapy in the prevention group were needed.

The back, sacral area and heels were monitored during the study; every 2 hours in the first day, every 4 hours in the second day, every 8 hours in the third day, and every 12 hours after the fourth day. Photographs were taken at regular interval for comparison of the outcome. Informed consents were obtained from patients and relatives.

Patients with immunocompromized condition (positive antiHIV or Chemotherapy) were excluded.

Outcome measurement

Demographic data including age, sex, body weight, diagnosis, underlying diseases, level of serum albumin, and duration of study were recorded. The primary outcome in prevention group is reported in percentage of ulcer occurrence. Outcomes in the treatment group are reported in percentage of healed, improved and not improved ulcers.

Statistical analysis

The continuous data are reported by mean and standard deviation. The counting data are reported by percentage. The primary outcomes are reported by percentage and 95% confidence interval.

Table 1 Braden score (Barbara Braden, RN, PhD, 2001)

Point	Score			
	1	2	3	4
1. Sensory perception	Completely limited	Very limited	Slightly limited	No impairment
2. Moisture	Constantly moist	Very moist	Occasionally moist	Rarely moist
3. Activity	Bedfast	Chairfast	Walks occasionally	Walk frequently
4. Mobilization	Completely limited	Very limited	Slightly limited	No limitation
5. Nutrition	Very poor	Probably inadequate	Adequate	Excellent
6. Friction and Shear	Problem	Potential Problem	Not apparent	-

High risk ≤ 12 , Moderate risk 13-15, Low risk 16-18

Table 2 Pressure ulcer grading

Stage	Criteria
I	Hyperemia. Observed within 30 minutes or less, manifested by redness of the skin, which disappears within 1 hour after pressure is removed.
II	Ischemia. Develops if pressure is continuous for 2 to 6 hours. In contrast to hyperemia, redness from ischemia requires at least 36 hours to disappear after pressure is relieved.
III	Necrosis. Pressure not relieved within 6 hours may produce necrosis which is detected clinically by blueness of the skin or lump similar to a boil. The necrosis does not disappear at the definite time interval after pressure is relieved.
IV	Ulceration. Within 2 weeks a necrosis area may become ulcerated and infected. If pressure sore progresses to this stage, bony prominences may become involved and destroyed.

Source: Edberg EL, Cerny K, and Stauffer ES. Prevention and treatment of pressure sores. Phys Ther 53: 246, 1973. Reprinted with the permission of the American Physical Therapy Association.

RESULTS

Prevention group

Twenty-one patients (male:female = 20:1) were included in the prevention group (Table 3, 4). The evaluation period varied from 4-55 days (means &

standard deviation = 19.9 ± 15 days). At the end of the evaluation, all of the patient's skins were normal without evidence of pressure ulcer development (Figure 5-8).

Treatment group

Twenty-seven patients (male:female = 24:3) were included in the treatment group (Table 3,4). The evaluation period varied from 4-500 days (mean & standard deviation = 55.7 ± 98.2 days). In 27 patients, ulcer healing was completed in 9 patients [33.3% (95%CI = 32.4-34.2)], improved in 17 patients [63% (95%CI = 62.1-63.9)] and not improved in only 1 patient [3.7% (95%CI = 2.8-4.6)] but the evaluation period was only 8 days (Figure 9-18).

Table 3 Sex distribution in prevention and treatment group

	Male	Female	Total
Prevention group	20	1	21
Treatment	24	3	27
Total	44	4	48

Table 4 Patient characteristics in prevention and treatment groups

	Age (yrs)	Weight (kg)	Braden score	Duration (days)	Albumin (mg%)
Prevention (N = 21)					
Mean	50.7143	68.8095	7.9524	19.9048	3.0048
Std deviation	14.66337	18.09038	.21822	15.00302	.45550
Minimum	30.00	50.00	7.00	4.00	1.80
Maximum	85.00	140.00	8.00	55.00	3.80
Treatment (N = 27)					
Mean	56.4444	70.7407	8.2593	55.7037	2.7778
Std deviation	20.83513	28.61225	.90267	98.20145	.45007
Minimum	21.00	50.00	7.00	4.00	2.00
Maximum	99.00	200.00	10.00	500.00	4.00
Total (N = 48)					
Mean	53.9375	69.8958	8.1250	40.0417	2.8771
Std deviation	18.43610	24.35311	.70334	75.84586	.46184
Minimum	21.00	50.00	7.00	4.00	1.80
Maximum	99.00	200.00	10.00	500.00	4.00



Figures 5 Case 1, day 1, in a 56-year-old man, body weight 65 kg, unconscious from brain anoxia, Braden score 8



Figures 6 Case 1, day 16, without changing position, all skins were normal



Figure 7 Case 2, day 1, in a 60-year-old man, body weight 65 Kg, unconscious from head injury, Braden score 8



Figure 8 Case 2, day 35, without changing position, all skins were normal



Figure 9 Case 3, day 1, a 65-year-old man, body weight 120 Kg, unconscious from CVA, Braden score 9. He had grade III pressure ulcers at occipital area and grade II at sacral area.



Figure 10 Case 3, day 8, all pressure sores were at the same size, so we classified this patient in not-improved group.



Figure 11 Case 4, day 1, a 40-year-old man, body weight 70 Kg, paraplegia from T-spine fracture, Braden score 10. He had pressure sores grade IV at sacral area, both trochanteric areas and right lateral malleolus.



Figure 12 Case 4, day 500, all pressure ulcers were markedly improved.



Figure 13 Case 5, day 1, a 37-year-old man, body weight 200 Kg, could not moved his body from C-spine injury, Braden score 8. He had pressure sores grade IV at sacral area and grade II at both trochanteric areas.



Figure 14 Case 5, day 90, all pressure sores were markedly improved



Figure 15 Case 6, day 1, a 75-year-old man, body weight 70 Kg, unconscious from head injury, Braden score 8. He had pressure sores grade IV at sacral areas and grade II at right trochanteric areas.



Figure 16 Case 6, day 23, the pressure sores at right trochanteric area was completely healed and markedly improved at sacral areas.



Figure 17 Case 7, day 1, a 63-year-old woman, body weight 60 Kg, CVA, Braden score 10 She has grade II pressure sores at sacral area.



Figure 18 Case 7, day 44, the pressure sores were completely healed.

DISCUSSION

The best way to prevent the development of pressure ulcers is to turn the patient every hour which is difficult in clinical practice¹. A lot of models of the mattress were invented to solve this problem but none of them provides maximum effectiveness. All of them cannot eradicate pressure to zero. These devices may be classified into 2 groups; pressure reducing group which can reduce pressure, but not below 32 mmHg and pressure relieving group which can reduce pressure below 32 mmHg.² Air-fluidized beds, which were the most effective devices, have been shown to reduce the development of pressure ulcers in intensive care unit patients. But when 98 patients were randomized into an air-fluidized bed and conventional mattress, fewer patients developed pressure ulcers on air-fluidized beds.³ This means that air-fluidized bed still cannot completely prevent pressure ulcers.

Yanin Beds use the principle of pressure alternation. The mattresses are made of solid material instead of soft or malleable material. The advantage of solid material is that it does not change its shape by weight, then the alternated area can be accurately controlled. When movable part moves up and down, patient's skin does not touch the lower mattress. Then the pressure can be relieved to zero every 5 minutes and the circulation of the tissue at prominent bone was not disturbed. Movement of the bed was by the use of hydraulic jack which can lift heavy patient without any effect on the efficacy of the bed. (Figure 1-4)

This study was conducted in patients with serious conditions which would accelerate the process of pressure ulcers development. Volunteers were high risk patients with Braden score <12 (most of the studies used moderate risk with Braden score <16) and could not change their position during the study. Theoretically, when the patients lie down, the process of

pressure ulcer development will occur step by step from hyperemia, ischemia, necrosis and finally ulceration. However, all volunteers were free from ulcer on Yanin bed although their positions did not change for the entire period of the study.

Heavy patients had no effect on the efficacy of the bed. Patients who developed pressure ulcers before joining this study were treated by position change every two hours but pressure ulcers still developed. After being enrolled into this study, pressure ulcers markedly improved although they lied over the ulcers. Meanwhile the skins in other areas were normal.

There are several strategies for the prevention and treatment of pressures ulcers.⁴ Prevention of pressure ulcers is a key factor because treatment can be difficult. Given current evidence, using support surfaces, repositioning the patient, optimizing nutritional status, and moisturizing sacral skin are appropriate strategies to prevent pressure ulcers. Although a number of randomized control trials (RCTs) have evaluated preventive strategies for pressure ulcers, many of them had important methodological limitations.⁵

Prevention plans require the skin to be kept clean and moisturized, frequent careful changing of body position (with proper lifting, not rubbing across surfaces), use of special mattresses or supports, management of other contributing illnesses, and implementation of a healthy diet. Relieving or reducing the pressure on the area is essential. Once an ulcer develops, additional treatment options can include local ulcer care (maintaining proper moisture balance and use of anti-bacterial dressings), debridement (removing dead tissue), keeping unaffected tissue around the pressure ulcer clean and lightly moisturized and surgical intervention to provide muscle flaps and skin grafts for some patients.

With the new invention of "Yanin bed", the results

of the study showed that it is useful to prevent and heal the pressure ulcers. This innovation may be a new additional strategy for prevention and treatment of pressure ulcers.

CONCLUSIONS

Several theories have been proposed to account for the development of pressure ulcers. The most important factor is direct pressure. If we can control this factor, other factors such as shear forces, malnutrition and anemia seem less important. Avoidance of pressure is the guiding principle to the prevention of pressure ulcers. Ideally, the patient is turned every hour, but this principle is difficult to practice. The pressure reducing devices previously reported cannot completely prevent the development of pressure ulcers and the effective results vary from each study. Therefore, the prevention can be done by one of the following techniques; turning patients every hour or turn patients every two hours plus the use of pressure reducing device. The results of this study showed that Yanin bed is useful to prevent the development of pressure ulcers in high risk patients.

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