VOLUME 18 / NUMBER 4 — JULY/AUGUST 1999

Orthopaedic Nursing

Pediatric Trauma

Substance Abuse in the Elderly

Pain Control in Total Joints

National Association of Orthopaedic Nurses

Clinical Evaluation of an Automated Turning Bed

Helen I. Melland ◆ Diane Langemo ◆ Darlene Hanson
Bette Olson ◆ Susan Hunter

Purpose: The purposes of this study were to assess client comfort and sleep quality, client physiologic response (skin and respiratory status), the effect on the need for caregiver assistance, and cost when using an automated turning bed.

Design: Nonexperimental, evaluative study

Sample: Twenty-four adult home or long-term care resident subjects who had a degenerative disease, spinal cord injury, stroke, cerebral palsy, or back surgery.

Methods: Each subject agreed to use the automated turning bed for four weeks. Researchers completed a demographic survey and skin assessment, and assessed each subject for pressure ulcer risk and for the need of assistance of a care giver for turning before and after the four weeks of using the turning bed. Subjects rated the turning bed in terms of comfort and sleep quality.

Findings: Subjects rated the turning bed as more comfortable than their own bed and expressed satisfaction at the pain relief attained when on the turning bed. While using the turning bed, there was a significant improvement in sleep quality. No skin breakdown or deterioration in respiratory status occurred.

Fewer subjects required the assistance of a caregiver for turning when on the turning bed.

Conclusion: This automated turning bed shows great promise in meeting a need for patients with limited mobility whether they are homebound or in a residential community.

Implications for Nursing Research: Future studies that further investigate use of the turning bed for postoperative back patients while still in the acute care setting are indicated. Replicative studies with a larger sample size are also indicated.

A priority nursing concern when caring for patients with orthopaedic problems is to protect them from the complications of immobility. When an individual is immobile or even less active than normal, serious, deleterious side effects can occur. Inactivity, immobility, and fewer than necessary body position changes can lead to compromised skin integrity, particularly over bony prominences, and compromised function of many body organs and organ systems. These effects can range from slight to catastrophic.

The longer an individual is immobilized, the more profound will be the systemic complications. The costs associated with the complications of immobility are staggering in terms of human suffering, physiologic damage, and real dollars (Allman et al., 1995; Carpenito, 1995; Hale, 1990; Olson, 1967).

Body systems most severely impacted by immobility include the cardiovascular, respiratory, gastrointestinal, musculoskeletal, genitourinary, and integumentary. Cardiovascular complications resulting from immobility include orthostatic hypotension, increased workload of the heart, and thrombus formation.

During periods of immobility, the basic metabolic rate is decreased, resulting in less demand for oxygen by the cells (Olson, 1967). As a consequence, respirations become slower and more shallow, resulting in decreased movement of secretions and/or a pooling of secretions. The sequelae of that pooling include bronchitis, atelectasis, or hypostatic pneumonia. Decreased oxygenation of tissues can also increase the chance and speed of skin breakdown. The impact

Helen I. Melland, PhD, RN, is an Associate Professor in the College of Nursing at the University of North Dakota in Grand Forks, North Dakota.

Diane Langemo, PhD, RN, is a Professor in the College of Nursing at the University of North Dakota in Grand Forks, North Dakota.

Darlen Hanson, MS, RN, is an Assistant Professor in the College of Nursing at the University of North Dakota in Grand Forks, North Dakota.

Bette Olson, MS, RN, is an Associate Professor in the College of Nursing at the University of North Dakota in Grand Forks, North Dakota.

Susan Hunter, MSN, RN, is an Associate Professor in the College of Nursing at the University of North Dakota in Grand Forks, North Dakota.

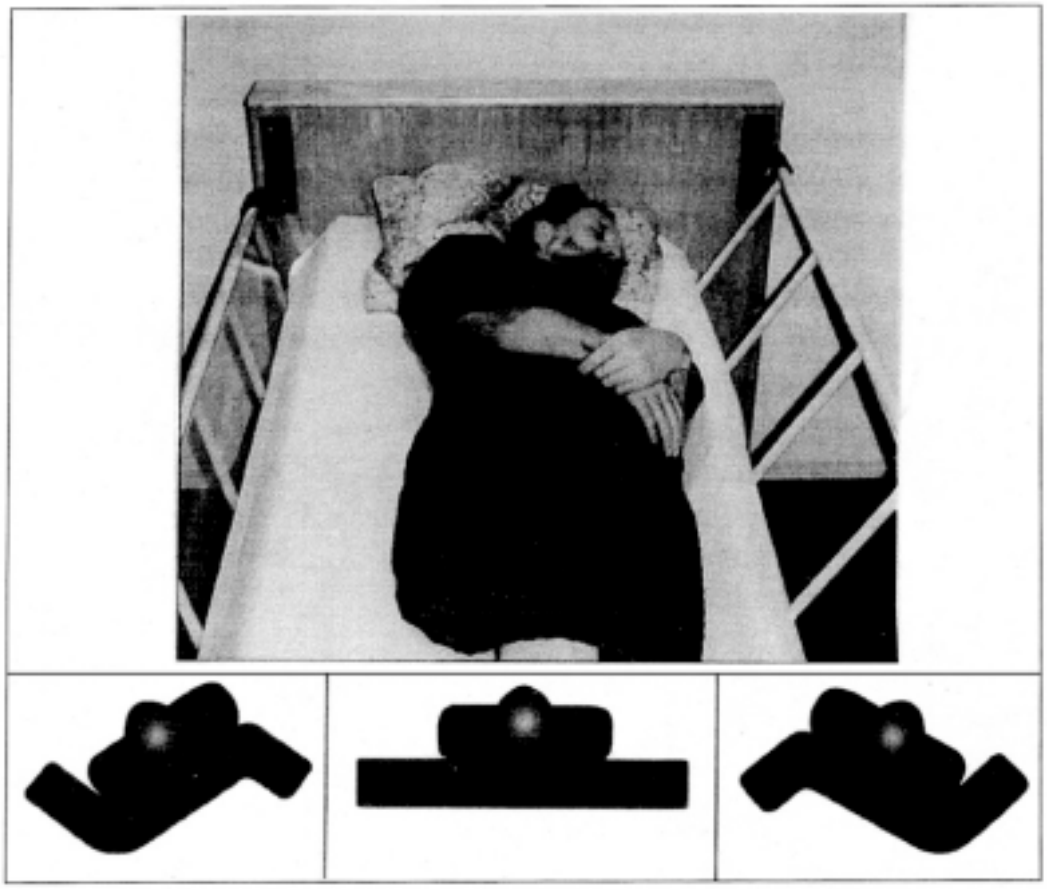

Figure 1. Lateral rotation of automated, computer-controlled bed.

of immobility on the gastrointestinal system is decreased peristalsis resulting in constipation or even fecal impaction. Associated anorexia can result in decreased protein intake and consequently a state of negative nitrogen balance, leading to decreased ability to fight infection and impaired tissue healing ability.

Changes in the musculoskeletal system include osteoporosis, decreased muscle mass, atrophy, and contractures. Renal calculi and urinary tract infections are complications of the genitourinary system that result from immobility. The skin often sustains severe damage in the form of pressure ulcers when an individual is immobile (Carpenito, 1995; Makleburst & Sieggreen, 1996; Olson, 1967).

Turning bed-bound, less active, and inactive patients at least every 2 hours is one of the most effective strategies in managing and decreasing the complications of immobility. The Agency for Health Care Policy and Research (AHCPR) clinical practice guideline *Pressure Ulcers in Adults: Prediction and Prevention* states:

> Individuals in bed assessed to be at risk for developing pressure ulcers should be repositioned at least every 2 hours if consistent with overall patient goals. A written schedule for systematically turning and repositioning the individual should be used. (Agency for Health Care Policy and Research [AHCPR], 1992, p.4)

The accepted standard in clinical practice for preventing pressure ulcers and other complications of immobility is to either turn patients manually at frequent intervals or to use a pressure-reducing device (AHCPR, 1992).

Most of these specially designed products fit into one of the following categories: mattress overlay, mattress replacement system with or without adjuvant features, low air loss bed with or without adjuvant features, powered patient rotation bed, or air fluidized bed. A mattress overlay, which is placed on top of a standard mattress, is by definition 3 inches thick or less, may be static or dynamic, and is constructed of foam or has individual "cells," which may be filled with air, water, gel, or foam.

A mattress replacement system replaces the entire hospital or home bed mattress, exceeds 3 inches in thickness, may differ in the contents of the cells (water, air, gel, or hybrid), connection of air cells, and the process of air loss or alteration of air cell pressure. Many of these systems offer rotation that may partially "turn" the patient up to 30-40 degrees through the process of inflation and deflation of air cells beneath the patient.

Low air loss beds are fully integrated systems providing pressure relief, moisture evaporation, and material with a low friction coefficiency that also addresses shear forces. The air-fluidized bed offers body support as a result of immersion in a constantly moving "tub" of silicon beads (Tallon, 1996). There are advantages and disadvantages to each of these devices. As stated by Evans et al. (1995), "Their usefulness in ulcer healing is not as certain [as turning], and no one product has been shown to be clearly superior" (p. 793). A need exists for continued ongoing research on the effectiveness of current pressure-reducing devices in

terms of dollars, physiologic damage, and human suffering, as well as for research and development of new pressure-reducing devices that may be even more effective.

A newer solution is a bed surface that turns the patient at regular intervals. The Freedom Bed® (model #PAR3-A2), which was evaluated in this study, is a computer-controlled, programmable, automatically-operated or manually-operated, powered patient rotation bed.

The bed surface is constructed of three longitudinal aluminum surfaces all joined together, with 50% of the width on the center section and 25% on each side section. Four inches deep, medical grade high performance foam, also divided into the same three sections (but connected) serves as the mattress. This mattress is covered and joined by water-resistant urethane coated nylon fabric, with the center section having a StaphChek® base. The foam has met United States government flammability tests, with the cover passing fluid leak and disinfection tests.

The bed is designed to provide accurate and automatic powered longitudinal rotation from 1 to 30 degrees, left or right, and to remain in left, right, or horizontal positions from 1 minute to 4 hours. As the center section of the mattress rotates to the left or right, the outer section rotates up, supporting and preventing the patient lying on the center section from sliding or falling out of the bed (see Figure 1).

The bed has two modes of operation: automatic, which turns according to information programmed into the computer; and manual, which overrides the computer, allowing the patient or caregiver to change positions at will. In case of a power outage when using the bed, there is a built-in backup battery system, which functioned well for a patient on the bed during a prolonged power outage during the course of this study.

A newer model of the bed than what was used in this study is equipped with features such as Hi-Lo elevations, Trendelenburg and reverse Trendelenburg positions, or the ability to raise or lower the head or foot sections

Purpose

The purposes of this study were to assess client comfort and sleep quality, client physiologic response (skin and respiratory status), the effect on the need for caregiver assistance, and cost when using an automated turning bed. The four research questions were:

1. What is the difference in client perceived comfort and sleep quality when using an automated turning bed versus his or her current bed?
2. What is the difference in the incidence of skin irritation and/or breakdown and pulmonary congestion when using an automated turning bed compared to the client's current bed?
3. What is the effect on the need for caregiver assistance when the client uses an automated turning bed versus a standard bed?
4. What is the difference in the cost of caring for a client on an automated turning bed versus a standard bed?

Table 1
Primary Diagnosis of Subjects

Primary Diagnosis	Number of Subjects
Multiple Sclerosis	3
Spinal Cord Injury – Quadriplegia	2
Spinal Cord Injury – Paraplegia	1
Post Spinal Fusion Surgery or Laminectomy	3
Cerebrovascular Accident	2
Degenerative Disk Disease	2
Cerebral Palsy	1
Rheumatoid Arthritis	1
Post Head Injury	1
Celiac Plexus Injury	1

Methods

Twenty-four adult home or long-term care resident subjects who had a degenerative disease (e.g., degenerative disk disease, multiple sclerosis), spinal cord injury, stroke, cerebral palsy or back surgery (see Table 1) and who currently lived in the north central part of the United States consented to use the automated turning bed at no charge for 4 weeks. Advertisements describing the study and recruiting potential subjects were placed in the local newspaper.

Subjects were also recruited by word-of-mouth contacts, networking with health professionals in the community, and through demonstrating the bed to health care professionals and individuals with a disability at an open house. Each subject or the subject's legal guardian signed a consent agreeing to participate and guaranteeing no recriminations if the subject chose not to complete the 4-week trial period.

All but one subject were alert and oriented and able to respond to questions regarding comfort and sleep. For this subject, the nursing staff provided information as available. No patient names were recorded to assure confidentiality for all subjects.

The data collection form, 56 objective items, was designed by the five nurse researchers after they had conducted a thorough literature search. To ensure content validity, the researchers discussed and, after making appropriate revisions, reached a consensus on the inclusion and interpretation of all items on the form.

The data collection form included a demographic section, and a section that included items assessing comfort and sleep patterns and physiologic parameters at the time of enrollment and after using the bed for 4 weeks. Specifically, subjects were asked to rate their comfort on their own bed and on the turning bed using a scale of 1 = poor to 5 = excellent.

Table 2
Subject Demographics

Variable	Characteristics of Subjects (N=17)
Age	M = 48.7; SD = 14.0; Range = 35-82 years
Gender	53% male; 47% female
Hours spent in bed per 24 hours	M = 10.8; SD = 6.8; Range = 2-24 hours
Caregiver help needed for turning	Yes = 59%; No = 41%
Help with turning at night	Spouse = 4; other family member = 1; hired assistant = 5
Braden Score upon enrollment	M = 17.5; SD = 3.7; Range = 11-22
Braden Score upon completion	M = 17.7; SD = 3.8; Range = 11-23

Subjects were next asked to rate their sleep quality on their own bed and on the turning bed using a visual analog scale with 10 being the best night's sleep to 1 being the worst night's sleep they could imagine.

Each subject's risk for pressure ulcer development was assessed when enrolling in the study and at the completion of 4 weeks on the bed, using the Braden Scale for Predicting Pressure Sore Risk (Braden & Bergstrom, 1988). This scale rates an individual's risk of pressure ulcer development according to six subscales: sensory perception, moisture, activity, mobility, nutrition, and friction/shear.

The maximum possible score is 23. Lower scores predict more risk for pressure ulcer development with a score of < 18 indicating a risk of ulceration (Bergstrom et al., 1998). The AHCPR guideline for pressure ulcer prediction and prevention recommends using the Braden Scale or another scale, the Norton Scale, based on current reliability and validity testing (Makleburst & Sieggreen, 1996) when assessing pressure ulcer risk.

Upon enrollment in the study, an investigator visited with the subject to explain the purpose and process of the study, obtained written consent, completed the demographic survey, performed a skin and respiratory assessment, assessed each subject for sleep comfort and satisfaction, and rated each subject using the Braden Risk Assessment Scale. Service technicians from a local durable medical equipment and supply company provided field support services as they set up the turning bed for each subject and dismantled and removed the bed at the conclusion of study participation.

Within 24-48 hours after placing the subject on the bed, a researcher made telephone contact with the subject or the subject's primary caregiver to identify potential problems that may have arisen as a result of using the bed, to assess the degree of satisfaction, and to answer questions. At least one other contact was made during the remaining time each subject used the bed.

After using the turning bed for the 4-week study duration, a follow-up visit was made by the investigator to assess skin and respiratory function, complete an assessment for pressure ulcer formation using the Braden Scale, and assess sleep comfort and satisfaction while on the bed. All subjects who completed the study received a monetary compensation of $100.

Results

Sample

Twenty-four subjects were enrolled in the study, and 17 (71%) completed the 4-week study. Fifteen of the 17 completing subjects (88%) lived at home, and 2 subjects (12%) resided in long-term care facilities. Five of the 7 subjects (71%) who did not complete the study asked to be dropped from the study because they wanted to elevate the head of the bed, a function not provided by the bed model used in the study. Table 2 displays the demographics of the participating subjects.

Research Questions

Research Question 1

What is the difference in client perceived comfort and sleep quality when using an automated turning bed versus his or her current bed?

The mean comfort rating prior to the study on the subject's own bed was 3.4 (SD = 1.12); comfort rating was slightly higher on the turning bed (M = 3.7; SD = 1.22). A t test comparing the difference in these comfort ratings was not statistically significant (t = -0.86, df = 14, p = .40).

Some subjects experienced a subjective decrease in physical symptoms when using the turning bed. For example, a quadriplegic subject said his neck did not hurt when on the turning bed as compared to being on his regular bed. Three subjects who had had spinal surgery found the bed so comfortable that they wished they could have been on the bed during their postsurgical hospitalization. A 37-year-old thoracic-lumbar spinal cord injured patient wished this bed had been available closer to the time of his accident. Some subjects expressed concern about the firmness of the mattress, and a few heavier subjects found it somewhat constrictive.

Sleep quality was significantly lower, therefore of poorer quality, on the client's own bed (M = 5.27, SD = 2.34) than on the turning bed (M = 7.43, SD = 1.60). A t test revealed this difference to be statistically significant (t = -2.55, df = 13, p = .024).

Eight of the 17 subjects (47%) agreed or strongly agreed that they slept better on the automated turning

Table 3
Number of Patients Who Needed Help Turning by Bed Type

Needed help turning on old bed	Needed help turning on new bed: Yes	Needed help turning on new bed: No
Yes	2	8
No	0	7

Because the turning of postoperative laminectomy and spinal fusion patients is labor intensive, hospitals may want to consider using a turning bed on their postoperative units.

bed than on their regular bed. While the average number of times the subjects awakened during the night on the turning bed (M = 2.92, SD = 1.43) was much lower than the number of times (M = 5.38, SD = 4.61) they awakened prior to being placed on the bed, the difference was not statistically significant (t = 1.40, df = 11, p = .19).

Research Question 2

What is the difference in the incidence of skin irritation and/or breakdown and pulmonary congestion when using an automated turning bed compared to the client's current bed?

Only 2 of the 17 subjects had skin irritation or a pressure ulcer on admission to the study. One subject, a 49-year-old female, had eczema upon enrollment which dissipated after 4 weeks in the study. No other subjects developed skin irritation during the study. A terminally ill 75-year-old female had five pressure ulcers when she enrolled in the study; four of the ulcers improved or healed after using the turning bed for 4 weeks.

All 17 subjects had clear lung sounds when enrolling in the study and also after 4 weeks on the bed. Two subjects reported a history of being prone to respiratory infections, yet their lungs were clear to auscultation when placed on the bed and for the duration of the study. Another subject, who had clear lungs when enrolling in the study, did develop pneumonia after having been on the bed for 8 days. At the conclusion of the study, her lungs were clear without the use of antibiotics.

Research Question 3

What is the effect on the need for caregiver assistance when the client uses an automated turning bed versus a standard bed?

Ten of the 17 subjects who completed the study required assistance with turning during the night prior to using the turning bed. Assistance was provided by hired staff for 5 subjects, by the spouse for 4, and for 1 subject it was another family member. While on the turning bed, only 2 subjects required assistance with turning, and 15 did not (see Table 3).

Subjects who required assistance included a 75-year-old female in a nursing home with rheumatoid arthritis and congestive heart failure and an 82-year-old male who had had a stroke and femoral neck fracture. For those two subjects requiring assistance turning while on the turning bed, the primary form of assistance provided by nursing home staff was positioning of the arms and shoulders for individualized needs and comfort.

The Wilcoxon's Matched-Pairs Signed-Ranks Test (Howell, 1982) revealed a significant difference between the number of subjects who needed help turning on their own bed versus the automated turning bed (z = -2.828, df = 1, p = .005).

Research Question 4

What is the difference in the cost of caring for a client on an automated turning bed versus a standard bed?

In situations where a caregiver's sole responsibility is for turning assistance, use of the turning bed could result in a great potential cost savings. This is rarely the case with daytime care, but during the night, turning assistance may be the only responsibility of a caregiver.

The decrease in the need for caregivers whose sole responsibility is for turning assistance could result in a great potential cost savings. The mean hourly wage for a certified nursing assistant (CNA) in home care in this geographic area is $7.66.

At that rate, the cost of hiring a CNA for one 8-hour shift per 24 hours for a year would be $22,367. If caregiver assistance is needed for 24 hours/day, then the cost of a CNA for 1 year would be $67,101.

Given the $12,000 cost of the turning bed, the bed would be paid for in saved wages, in just over 6 months if a CNA were employed for an 8-hour shift each day. If a CNA were employed for 24 hours each day, the bed would be paid for in slightly less than 3 months. The resultant cost-benefit ratio would be excellent.

It is important to also consider costs in terms of human suffering and potential caregiver injuries. These may include increased comfort of the patient in not being physically moved by others and the elimination of caregiver back injuries. In addition, patients may experience an emotional lift with increased independence, and family members or caregivers may be allowed to sleep through the night.

Discussion and Recommendations

The investigators had expected the bed to be of most value to patients with a spinal cord injury or a cerebrovascular accident. Instead, patients with severe back pain and postlaminectomy or spinal fusion surgery expressed the most enthusiastic positive responses. That may or may not have been a function of the younger age of those subjects with back problems who had better communication skills, as opposed to the older stroke patients.

Because the turning of postoperative laminectomy and spinal fusion patients is labor intensive, hospitals may want to consider using a turning bed on their postoperative units. Future studies that further investigate using an automated turning bed for postoperative back patients are indicated. Replicative studies with a larger sample size investigating client comfort and sleep quality, as well as the incidence of immobility complications, are needed.

Conclusions

The automated turning bed shows great promise of filling a significant gap in the "bed market" for patients with limited mobility. Subjects with spinal cord injury, degenerative back conditions, multiple sclerosis, post-spinal surgery, and immobility from stroke responded very positively with improved sleep quality and comfort, and less help needed with turning.

No skin breakdown occurred in those using the bed for 4 weeks. One patient developed pneumonia, but this was resolved without the use of antibiotics. The savings in caregiver dollars for turning is significant. In health care agencies, the potential savings in staff time for turning patients requiring assistance is potentially monumental.

References

Agency for Health Care Policy and Research (1992). Pressure ulcers in adults: Prediction and prevention. *Clinical Practice Guideline, Number 3.* AHCPR Publication No. 92-0047. Rockville, MD: Agency for Health Care Policy and Research, Public Health Service, U.S. Department of Health and Human Services.

Allman, R. M., Goode, P.S., Patrick, M. M., Burst, N., & Bartolucci, A. A. (1995). Pressure ulcer risk factors among hospitalized patients with activity limitation. *Journal of the American Medical Association, 273*(11), 865-870.

Bergstrom, N., Braden, B., Kemp, M., Champagne, M., & Ruby, E. (1998). Predicting pressure ulcer risk A multisite study of the predictive validity of the Braden Scale. *Nursing Research, 47*(5), 261-269.

Carpenito, L. J. (1995). *Nursing diagnosis application to clinical practice* (6th ed.). Philadelphia: Lippincott.

Evans, J. M., Andres, K. L., Chutka, D. S., Fleming, K.C., & Garness, S. L. (1995). Pressure ulcers: Prevention and management. *Mayo Clinic Proceedings, 70*, 789-799.

Hale, C. (1990). Pressure sores: Assessing the cost. *Nursing Times, 86*, 66-70.

Howell, D. C. (1987). *Statistical methods for psychology* (2nd ed.). Boston: PWS-Kent.

Makleburst, J., & Sieggreen, M. (1996). *Pressure ulcers guidelines for prevention and nursing management* (2nd ed.). Springhouse, PA: Springhouse.

Olson, E. V. (1967). The hazards of immobility. *American Journal of Nursing, 67*(2), 779-796.

Tallon, R. W. (1996). Support surfaces: Therapeutic and performance insights. *Nursing Management, 27*(9), 57-59.

Acknowledgment

This study was partially funded by ProBed Medical Technologies, Inc. of Abbotsford, British Columbia, and the University of North Dakota College of Nursing.