Development of a checking system for body mechanics focusing on the angle of forward leaning during bedmaking*

Kimiwa ITAMI*, Toshihiko YASUDA*, Yukinori OTSUKI**, Muneatu ISHIBASHI*** and Takanori MAESAKO***

*1 School of Human Nursing, The University of Shiga Prefecture, 2500, Hassakacho, Hikone, Shiga, 522-8533 Japan
*2 School of Engineering, The University of Shiga Prefecture, 2500, Hassakacho, Hikone, Shiga, 522-8533 Japan
*3 Graduate School of Human Sciences, Osaka University, 1-2, Yamadaoka, Suita, Osaka, 565-0871 Japan

Received for publication, January 29, 2010

Occupational low back pain is a serious problem among nurses, and the incidence of low back pain and the rate of absences resulting from low back pain are high among new nurses. Therefore, measures for low back pain are urgently required from the perspective of preventing the loss of nurses. In addition, as low back pain also frequently develops among nursing students during training at hospitals, measures for preventing low back pain must be established from an early stage, in other words basic nursing education. Forward leaning, which involves the forward flexion of the upper body, is a cause of low back pain developing during nursing actions. However, the application of body mechanics, which promote efficient actions, improves posture and may lead to prevention of low back pain.

Therefore, in the present study, we focused on bedmaking, an action that nursing students learn at an early stage as a basic nursing technique, and developed a "checking system for body mechanics" that enables self-checking of the angle of forward leaning during actions. The results of an evaluation experiment on nursing students revealed that 1) the system enabled users to objectively and easily assess their nursing actions, and 2) the angle of forward leaning during actions remained ≤30°, the range in which minimal burden is placed on the lower back. The objectives of system development were thus achieved.

Key words: occupational low back pain, body mechanics, checking system, prevent lower back pain, nursing actions

1. INTRODUCTION

Low back pain is an important issue that was taken up early in the field of occupational health. In the nursing profession, low back pain has also been called “occupational low back pain” and affects a larger proportion of people than in other occupations (Ohara et al. 1993). The incidence of severe low back pain that requires work leave is also high (Koda et al. 1991), and low back pain in nurses profession has become a serious issue from the perspective of preventing people from quitting the profession. Similar situations with regard to low back pain exist in other countries, with reports that the incidence is 1.47 times higher in nursing than in other professions (Dehlin 1976), and that nursing is the profession with the most low back pain (Jensen 1987).

One of the background factors for this kind of occupational low back pain in nursing is the significantly higher frequency compared with other professions of unnatural postures such as forward bending and torsion in the upper body, and actions that involve handling heavy objects (Koda et al. 1991). From the results of a survey of the nursing profession, Kitanishi et al. (1995) reported that the posture causing low back pain was a semi-crouching position while bending forward in 73.6% of nurses, and that improving posture when performing nursing actions is important in relieving the burden on the lower back.

Although the Ministry of Health, Labor and Welfare announced a policy for the prevention of low back pain in the workplace in 1994, this policy has been adopted in few medical and care institutions among their measures to prevent low back pain. Innovations and developments are progressing in many fields, such as strengthening the abdominal and lower back muscles through

---

* This paper was originally published in *Jpn. J. Educ. Technol.*, Vol.33, No.1, pp.1-9 (2009)
exercise, supporting the lower back by wearing flexible corsets, and using support devices as means to prevent low back pain. However, such techniques are used in only a few medical and care settings (Yasuda et al. 2005). Among these techniques, the use of body mechanics is recommended as an easy and reliable way to prevent low back pain (Takemi 1998).

Good body mechanics lead to economically efficient action using the principles of physics and mechanics (Ogawa 2003), and the use of body mechanics can promote improved posture and prevent low back pain. However, body mechanics cannot be used in the workplace without a good understanding of the techniques. A survey of nurses indicated that nurses do not use proper body mechanics for reasons such as being too busy, and that they insufficiently understand body mechanics (Kurujima 2003).

One study has shown that 81% of nurses who had lower back pain started to experience the pain after they began working as a nurse, and the onset was relatively early; within 2 years of starting work as a nurse (Miyamoto et al. 1998). The incidence of low back pain among nursing students is reported to be 58.1% (Hijjkata et al. 1997). The high incidence of low back pain in nursing students during hospital training has also been pointed out (Klaver 1993). Measures to prevent low back pain therefore need to be implemented early, when nurses are still students; implementing measures at the start of employment may be too late (Furukabu et al. 2001).

Attempts have been made to develop educational materials related to body mechanics for nursing students. Mitto et al. (1999) conducted a study in which they prepared model videos that subjects watched, but they did not conduct an objective evaluation of how much improvement there was in the posture of individual students. In addition, Doi et al. (2000) conducted a study using 3-dimensional action analysis and Takahashi et al. (2006) investigated methods of teaching body mechanics using measurements of posture and surface electromyograms, but their methods relied heavily on laboratory investigations and it may not be easy to apply these approaches to individual students. Concrete learning support for the use of body mechanics to prevent low back pain should not only have students acquire knowledge, but also include a system that enables students to objectively evaluate their own actions (Doi et al. 2000).

We therefore previously attempted to develop a system to check the body mechanics of action with nursing students as subjects, and confirmed the high level of need for objective evaluation of one’s own nursing actions (Itami et al. 2007).

In this article we first introduce the process of development of the checking system for body mechanics, including evaluation of a trial system. The handling of heavy objects is among the nursing actions that place a burden on the lower back (Hirata 1990), but this system was developed with a focus on improving the posture of anterior leaning in which the upper body is bent forward, which is the most common factor in the onset of lower back pain from nursing actions. “Bedmaking actions,” which are learned in the early stages of nursing skills practice, were used in the system so that nursing students could learn body mechanics soon after starting nursing school.

In developing the system, we set the angle of forward leaning at less than 30°, which places minimal burden on the lumbar region. In the Nagamachi work diagnostic chart (1992), the burden increases as the angle of forward leaning becomes deeper, and the lowest burden is thought to be in postures with angles of 0–30°. In addition, Noda et al. (2001) incorporated a special elastic material in an appliance worn to prevent low back pain, designed to support the back muscles when the angle of forward leaning is greater than 30°. Thus, forward leaning of 30° may be considered an angle of caution for lumbar burden. Therefore, angles of less than 30° are set as a target for forward leaning in nursing actions.

As described above, the aim of this study was to develop and evaluate a checking system for body mechanics that enables self-checks of angle of forward leaning during actions, using the activity of bedmaking that is learned by students as a basic nursing skill at an early stage.

From the results of an evaluation experiment with nursing students as subjects, it was confirmed that the aims in developing the system were achieved; namely, that (1) nursing actions can be evaluated easily and objectively, and (2) the angle of forward leaning during actions was less than 30°, which has minimal lumbar burden.

2. TRIAL OF THE CHECKING SYSTEM FOR BODY MECHANICS AND ITS EVALUATION

2.1. Outline of the trial system

Objective data on the burden on the lumbar region and knees are input into the trial system,
and can be shown on the system computer monitor in real time during bedmaking actions. The objective data are (1) electromyography waveforms (from the bilateral erector spinae and unilateral biceps femoris), (2) lumbar and knee angles during actions, (3) a stick figure display that moves in tandem with the posture of the person wearing the system, and (4) a graph of degree of lumbar burden (joint moment that is determined by the angle of forward leaning). The system can also store and reproduce the measured data. Figure 1 shows a screen drawn by the system. In the case shown body mechanics are not being used properly (Setting 1 shown below). This is a typical case of forward leaning without bending the knees.

The initial trial system was created as a visual aid for group practice of nursing skills with nursing students as subjects. Therefore, using the trial system, bedmaking actions including differences according to the height of the bed with and without the use of body mechanics were shown visually. The following 4 settings were created for the depicted cases, reproduced and shown on the system monitor.

Setting (1): Low bed, body mechanics not used
Setting (2): Low bed, body mechanics used
Setting (3): Optimum bed height, body mechanics not used
Setting (4): Optimum bed height, body mechanics used

The screen depictions were created with the cooperation of 2 male nursing students (Student A and B) who had already learned the bedmaking actions. Both were asked to don the system and perform the bedmaking actions as modeled by the nursing instructor, and the nursing instructor confirmed whether the depiction on the system monitor was appropriate. Screen depictions were obtained from both students in the same way, but the data for Student A (height 160 cm, weight 57.0 kg), including objective data on bending of the lumbar region and knee, was found to be displayed in an easy-to-understand manner and was therefore used as a visual aid (Itami et al., 2007).

In performing bedmaking actions with the 4 different settings, the height of the low bed was 51.7 cm, but in the results of a survey by Fujita et al. (1999) this was the average height of adult beds in hospitals. Based on experimental results of Itami et al. (2000), the optimum bed height was calculated to be a bed height/body height ratio of 45%.

2.2. Evaluation of simulation exercise using trial system

A simulation exercise using the trial system was evaluated in January 2006 with the aim of demonstrating the viewing ease of the system display and the learning effect of using the system. In conducting the analysis, a simulation exercise was conducted with a group learning format and nursing students as subjects using trial system display screens saved as typical examples of the 4 settings, and a survey was conducted.

- Subjects
  The subjects were 22 second-year nursing students (2 men, 20 women) consented to participate in the study. The subjects included the 2 men who had already worn the trial system.

- Simulation exercise with group learning format
  A simulation exercise on the use of body mechanics was conducted using the replayed trial system display screens. The duration was about 40 min, including an explanation of the study background and an explanation of the use of body mechanics in the 4 different bedmaking settings in the reproduced display screens, using 2 screens.

- Survey content
  The survey included: 1) viewing ease of the trial system display function, 2) level of understanding of the use of body mechanics, 3) need for development of the system, and 4) opinions on the system. The evaluation was performed using a 5-point scale.

- Evaluation of viewing ease of the trial system display function
  The survey results on the viewing ease of the trial system display function are shown in Table 1. The highest score was for the display with the stick figure depicting the position of a person...
making actions. On a 5-point scale, the mean score was 3.95±0.90.

Next, the mean score for the real time graph display of electromyogram waveforms was 3.50±1.30. Similarly, the mean score for the lumbar burden graph was 3.41±0.96, and that for the joint angle shown with a “meter” was low at 2.95±1.21.

The free comments received included positive comments such as “the change of color for each major joint makes it easy to understand,” “the simple pictures were easy to understand,” and “the specific numbers were easy to understand.” However, negative comments were also received, including “I do not understand the meaning of the numbers simply by looking at them without knowing the evaluation criteria for them,” and “I couldn’t really understand the differences in electromyogram waveforms,” and “I don’t understand the meaning of ‘moment’.”

Learning effect of the simulation exercise using the trial system

The level of understanding of the use of body mechanics from group learning using the trial system display screens was evaluated on a 5-point scale, and the mean score was high at 4.05±0.65. In response to questions on the need for development of the system, a similarly high mean score of 4.09±1.06 was obtained for the question “Do you want to assess your own actions and learn to move using the system?” These results suggest that, in group learning on the use of body mechanics, the use of the replayed screen displays in this system may be useful as a learning tool and have a learning effect.

The 2 students who used the trial system gave it a high mean score of 4.5 points for “level of understanding of use of body mechanics.” Both students also gave it a full 5 points for “Do you want to assess your own actions and learn to move using the system?” Thus, an effect is thought to be gained from actually wearing the system and being able to objectively evaluate your own nursing actions.

2.3. Shortcomings and directions for improvement of the trial system

Evaluation of the simulation exercise using the trial system suggested the need to make the system displays easier to view and to improve the evaluation functions. Many comments along the lines of “I do not understand the meaning of the numbers simply by looking at them without knowing the evaluation criteria for them,” and “I couldn’t really understand the differences in electromyogram waveforms,” and “I don’t understand the meaning of ‘moment’” were received, and it is essential to clarify the points of evaluation and make the system understandable even to students who have just begun school. As indicated in the action study by Itami et al. (2003), the tensile force on the aponeuroses of the lower back increases with deep forward leaning or a static posture, and a greater burden is placed on the lumbar spine and tendons than on the muscles of the lower back, which is sometimes not shown in an electromyogram waveform. Moreover, understanding the meaning of joint moment is also difficult for nursing students who do not have knowledge of mechanics.

Meanwhile, improvements in the posture of forward leaning when handling heavy objects is essential for reducing lumbar burden, but the weight of the heavy object is also related to the burden (Hirata 1990). However, in learning the use of body mechanics in bedmaking actions that are practiced by nursing students soon after they enter school, content needs to be limited to key points so that the principles can be more readily understood by students, and goals also need to be clarified.

Therefore, the focus of evaluation in developing the system was on improving the posture of forward leaning in which the upper body is bent forward, which is the most common factor promoting low back pain in nursing actions. Bedmaking are recognized to be the nursing actions that most readily cause low back pain among nursing actions that do not involve heavy lifting (Kurujima 2003).

Through this trial we reconfirmed the high level of need for a system that enables objective evaluation of one’s own nursing actions. In addition, the 2 male students who actually used the trial system had a higher level of understanding and desire to use the system than
3. DEVELOPMENT OF A CHECKING SYSTEM FOR BODY MECHANICS AND ITS EVALUATION

3.1. Outline of the system

From their relationship with lumbar burden, "not adopting a posture of forward leaning" and "taking a wide, open stance with one leg forward and the other back, lowering the hips, and bending the knees" are known to be important for the use of body mechanics in bedmaking (Itami 2001).

The points in this system, therefore, are limited to postures of forward leaning and bending the knees in bedmaking, and the aim was to develop the system so that one's own nursing actions can be objectively and easily evaluated, and posture improvements can be promoted.

At the same time, similarly to with the trial system, even for students who have not worn the system, a learning effect can be expected with regard to the use of body mechanics by watching the system display screen.

In developing this system, evaluation indicators for the angle of forward leaning during actions were investigated as follows.

1) Investigation of evaluation indicators for angle of forward leaning

A posture of forward leaning has been defined as the angle against the horizontal plane passing through the iliac crest, with the straight line connecting the acromion and iliac crest taken as the base line (0°) (Ohata et al. 1997). The same definition was used in the present study. In addition, 2 indicators, a danger angle and a caution angle, were established for evaluation indicators of the angle of forward leaning. These 2 angles are thought to place an excessive burden on the lumbar region (danger angle) or to be avoided if possible (caution angle).

The danger angle is calculated based on height data for the subject being measured. When performing bedmaking the appropriate bed height is thought to be about 45% of the height of the person making the bed (Itami 2000). The danger angle was calculated based on this. Figure 2 shows the assumptions for calculating the danger angle. The bed height $H$ is taken to be 45% of the person's height. The body position of people performing bedmaking was assumed to be such that the person making the bed touched the bed with his or her hand by bending forward only while maintaining the lower body in an upright position. This is poor body position in which body mechanics are not being used at all. Based on this assumption, the following equation holds.

$$L_1 \cos \phi + L_2 + L_3 = H + L_5 \quad (1)$$

Because there is no use of body mechanics whatsoever, the angle of forward leaning $\phi$ [°] obtained from equation (1) is an angle that places an excessive burden on the lumbar region even with actions with a recommended bed height. This angle is defined as the danger angle, and is used in the evaluation function. From the above, the danger angle was calculated to be $\phi = 39.9$, and so an angle of 40° was adopted.

The caution angle was set at 30° based on the Nagamachi work diagnostic chart (1992) and the design of the support belt to prevent low back pain created by Noda et al. (2001).

At the request of the Ministry of Health, Labor and Welfare, Nagamachi established an evaluation method that judges the degree of burden by work position and showed that the burden was related to the angle of forward leaning in the lumbar area and the angle of knee flexion. According to this, the burden increases as the angle of forward leaning becomes deeper, and the burden is lightest with postures of 0–30°. The low back pain prevention appliance of Noda et al. was also designed to support the back muscles when the angle of forward leaning during use exceeded 30°, using a special elastic material built into the appliance.

Based on the above, in developing this system a danger angle of 40° and caution angle of 30° were established as evaluation indicators for the angle of forward leaning during action.

To avoid adopting postures of forward leaning it
is necessary to first understand one’s own actions; that is, to be able to easily and objectively evaluate one’s own angle of forward leaning. Ergonomically, the angle of forward leaning decreases when an open stance with one leg forward and the other back is adopted with the hips low and knees bent. Therefore, we decided to make a system that presented the angle of forward leaning simultaneously with the flexion angle of the knees, to enable students to evaluate their own body mechanics.

This system was developed with the aim of enabling nursing students using the system to achieve the following:

1. Easily and objectively evaluate nursing actions
2. Adopt angles of forward leaning of less than 30°, which places little burden on the lower back, during nursing actions (bedmaking)

2) System display function

In this system, the display is limited to action postures, and the system was devised so that learners can easily and objectively understand and evaluate whether their nursing actions are good or bad. The system display is shown as follows.

Posture during action (stick figure):

The depiction of the human body consists of 6 parts, such as the head and trunk. The reference points for measurements and depictions shift from the ankle to the tips of the toes, and actions in which the heel is lifted can also be measured. The entire figure is devised so that, in addition to thickness, the figure can be easily seen as “human.” Similarly to the trial system, posture during actions is depicted in real time.

Joint angle (meter, graph):

The angle of forward leaning and angle of knee flexion are shown simultaneously using both meter and graph. When data capture starts the angles are also shown numerically below each meter in real time.

The display is also arranged for easy understanding, with danger angles of 40° or more set as an evaluation indicator displayed in red, and caution angles of 30°—40° displayed in yellow, so that evaluations can be made (Fig.3). Explanations are given in the balloons in Fig. 3.

3) Creation of the posture measurement sensor appliance

People who donned the system were dressed in the nurses’ uniform and sandals used in nursing skills practice and hospital training. The sensors can be easily attached on top of the clothes.

![Fig. 3 A displayed example of checking system for body mechanics](image)

![Fig. 4 Wearing the sensor appliance to measure posture](image)

The sensors used detected the angle of forward leaning (angle of leaning sensors) and sensors to detect the angle of the leg joints to measure angle of knee flexion (goniometer). These sensors must be attached so as not to interfere with measured actions from on top of the clothes, and to stay in place during actions.

The appliance to measure the angle of leaning was made with sensors attached to the back part of a vest that could be adjusted for size using hook and loop fasteners, so that it could be fit to the body. The leg joint angle measurement device was made first with an ankle sensor attached to the person’s sandals, so that it could be fit snugly to the leg. The leg sensor was attached to an elastic fabric that was adjustable and could be fit to the leg. Figure 4 shows a person wearing the posture measurement sensor appliance from the back.

3.2 Change in angle when using this system

To confirm the changes in angle when using the system, the following evaluation experiments were implemented.

- Evaluation experiment methods

The subjects of the evaluation experiments were 5 first-year students (all women) who consented to
participate in the study. The subjects also participated in the above-mentioned group practice on the use of body mechanics.

This experiment was conducted using a group learning format, and the subjects were asked to select a person with a typical physique as a representative of each group. There were 5 groups, and the mean height of the 5 subjects was 162.7±2.2 cm and the mean weight was 52.1±5.1 kg.

The method of the evaluation experiments was to first attach the system to the subject, and then have them conduct the previously learned bedmaking in the order of Experiments (1)–(3) below. The angle data were then compared.

Experiment (1): Actions performed during regular self-practice

Experiment (2): Actions performed after subjective evaluation within the group in (1)

Experiment (3): Actions performed after objective evaluation using the system depiction screen within the group in (2)

The subjects in Experiment (1) were asked to perform the actions just as they did in normal practice, and whether or not they were using body mechanics was not specified. However, none of the subjects changed the bed height setting, and the mean bed height of 65.2±4.0 cm was somewhat low compared with their body heights.

In Experiments (2) and (3) all 5 subjects adjusted the bed height to the optimum height explained in the group learning exercise. The mean bed height in (2) and (3) was unchanged at 73.2±0.8 cm.

Meanwhile, even group members that did not wear the system themselves made subjective and objective evaluations within the group in accordance with the evaluation experiment, and exchanged opinions.

- Analysis method for evaluation experiments

To evaluate the degree of achievement of developmental goal (2) for the system mentioned above, the mean angle of anterior leaning and knee flexion angle during bedmaking obtained in each of the evaluation experiments were calculated, and compared for each experiment.

The angle data obtained in the evaluation experiments were aggregated and a t-test was conducted using SPSS 12.0 for Windows. The validity of this system used in Experiment (3) was demonstrated from the change in angle.

- Results and discussion of evaluation experiments

Table 2. Change in angle when wearing and using the system indicated in Experiment (3) (n = 5)

<table>
<thead>
<tr>
<th>Experiment content</th>
<th>angle of forward (°)</th>
<th>angle of knee flexion (°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment (1): Actions performed during regular self-practice</td>
<td>46.0±6.7</td>
<td>151.2±8.5</td>
</tr>
<tr>
<td>Experiment (2): Actions performed after subjective evaluation within the group in (1)</td>
<td>36.7±12.0*</td>
<td>135.6±15.2*</td>
</tr>
<tr>
<td>Experiment (3): Actions performed after objective evaluation using the system depiction screen within the group in (2)</td>
<td>27.4±7.8**</td>
<td>129.8±8.0**</td>
</tr>
</tbody>
</table>

*p < 0.05, **p < 0.01. Results of a t-test for each Experiment (1)

The results of the evaluation experiments are shown in Table 2 below.

In actions during regular self-practice (Experiment (1)), the mean angle of forward leaning was 46.0±6.7°, which is in the danger angle range where the burden on the lower back is the greatest, and the mean angle of knee flexion was 151.2±8.5°. The subjects had completed the group practice using the above-mentioned trial system display screen, but the evaluation in Experiment (1) was low and the need for individual study of body mechanics was reconfirmed.

Next, the method adopted in Experiment (2) may be considered group learning including the traditional nursing practice of repeating actions after receiving advice from other students in the group with regard to actions performed. In this case, the angle of forward leaning had improved from Experiment (1) to 36.7±12.0° and some improvement was seen, but the target of within 30° was not reached and the angle was within the caution angle range.

In contrast, in bedmaking performed after the objective evaluation of one's own actions using the system display screen (Experiment (3)), the mean angle of forward leaning was 27.4±7.6° in the safe range, and the mean angle of knee flexion was 129.8±8.0°. These actions were done with the knees bent and the hips lowered, and may be considered to use the best body mechanics. Experiment (3) had the same bed height as Experiment (2), and it was shown that even with the same bed height it is possible to improve posture with the use of body mechanics if actions are done with an awareness of angle of forward leaning and angle of knee flexion.

Therefore, even though the results were for only 5 subjects, it may be considered that the goal
of an angle of leaning of less than 30°, which puts minimal burden on the lower back, was achieved, and that the system will be effective in improving the posture of nursing students during bedmaking in the early stages of learning.

3.3. Evaluation of practice using this system

· Subjects

The subjects for practice using this system were 26 first-year nursing students (all women) who consented to participate in the study.

The subjects were the same students in the 5 groups that cooperated in the above evaluation experiments of the system, and included 5 students who had worn and used the system.

· Method of practice in group learning format

Conventionally, skills learning support is done using a group learning format in the practice of basic nursing skills.

We therefore implemented the practice of using body mechanics in a group learning format with the nursing students as subjects.

While conducting an evaluation experiment during bedmaking using this system as described above, body mechanics were practiced with a focus on angle of forward leaning.

· Survey content

After the practice was finished, we conducted a survey (5-point conversion method) on the ease of viewing system displays and the learning effect in order to evaluate the degree to which the system development goals had been met, with the 26 students who participated in the practice as subjects.

· Evaluation of viewing ease of system display function

The survey results on the viewing ease of the system display functions implemented after practice are shown in Table 3. The stick figure of posture during actions as a "human picture" had a mean score of 4.23 ± 0.71 when converted on a 5-point scale, and the indicators displayed with "meters," such as joint angle, had a mean score of 4.86 ± 0.41. These scores were considerably higher than the scores with the trial system.

Among the free comments, many comments such as "the angles classified by color were easy to understand," and "the data indicated with numbers also provided a specific understanding" were received. Compared with the trial system, the display screen was easier to understand.

· Learning effect of a simulation exercise using the system

Self-evaluations of practice using this system are shown in Table 4. In the evaluation of the practice using this system, all 26 subjects agreed that "the system is beneficial in supporting learning on the use of body mechanics," and "I can check my own nursing actions more objectively using this system." In addition, the group learning using the system also received high marks for attracting interest and being enjoyable.

Thus, the aim of "easily and objectively evaluating nursing actions" is considered to have been achieved through practice using the system, and a learning effect of practice using the system was seen.

4. SUMMARY AND FUTURE OUTLOOK

In this study, a "checking system for body mechanics" was developed that enables self-checks of angle of forward leaning in bedmaking, which nursing students learn early as a basic nursing skill. The results of evaluation experiments with first-year nursing students as subjects indicated the following.

1) The mean angle of forward leaning in bedmaking of 5 subjects using this system was 27.4 ± 7.6°, and an improvement in posture was seen.

2) In the evaluation of the practice using this system, all 26 subjects agreed that "the
system is beneficial in supporting learning of the use of body mechanics,” and “I can check my own nursing actions more objectively using this system.”

The above results indicate that the aims in developing this system were achieved, and suggest that the system is useful in learning appropriate postures of forward leaning that are the basis of good body mechanics.

In the future, in addition to nursing students, we would like to expand use of this system to newly qualified nurses, who have a high incidence of low back pain, with the goal of helping to prevent occupational low back pain among nurses.

ACKNOWLEDGEMENTS

We gratefully acknowledge the cooperation of students, School of Human Nursing, The University of Shiga Prefecture in this study.

We would like to express our gratitude for the partial support for this research from the Ministry of Education, Culture, Sports, Science and Technology, Grant-in-Aid for Scientific Research(C), (No.17592217, Representative: Kimiwa Itami).

REFERENCES


