

Physical Training to Improve Transfer Techniques and Strengthen the Musculoskeletal System of Nurses Caring for Chronically Sick Patients

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Abstract

Aim: The focus of the study is on the stresses affecting the musculoskeletal system of nurses transferring heavy patients to a standing position, which is regarded as a major cause of back pain. As mechanical aids like patient lifts are only available in isolated cases, the use of physical training courses and workouts to improve manual transfer techniques and strengthen the relevant musculature should be encouraged as a viable alternative.

Volunteer group, methodology: The study was performed in a group of 10 nurses (female participants only) caring for 20 heavy patients in an intensive care unit. The training course completed by the volunteers (lasting 5 months, 2 trainings per week) was designed to improve transfer techniques and reduce stresses caused by the heavy loads. Two computerized tests were used to evaluate the results: the MFT S3 - Body Stability Test and the Core Stability Test to determine balance capability and to determine strength profiles of the muscles stabilizing the spinal cord.

Results: Evaluation of the Body Stability Test results showed that a majority of volunteers completing the course (For simplicity's sake no gender differentiation is stated for nursing staff or patients) experienced improvement in transfer techniques and muscle function. The only values showing little or no improvement were those for symmetry and uniformity in activation of the passive musculoskeletal system. A review of the exercises used for this purpose would be useful. Evaluation of the Trunk Stability Test showed that participation in the course had resulted in functional improvements in excess of target value for the extensor muscles (to the rear of the trunk) and the flexor muscles (to the front). The before/after results for the muscles governing lateral inclination also showed improvements.

Conclusions: Although training courses to improve transfer techniques and muscle strength are a useful alternative for nurses transferring heavy patients in cases where mechanical aids are not available, they are rarely used by or for nurses. Furthermore, they are inadequate for long-term health maintenance, which normally requires comprehensive ergonomic training to eliminate ergonomically incorrect transfer practices. Ergonomic transfer training creates consciousness of the need for a minimum-stress approach to heavy dynamic work and development of a routine for ergonomically correct performance of this type of work. Also of great importance for enhancement and maintenance of nurses' health is good job organization.

Keywords: Patient transfer; Nurses; Care of chronically sick patients; Physical training; Organizational and functional training

Introduction

It is evident from analysis of nursing work in hospitals and nursing homes as well as reference to the literature [1] that members of the nursing profession are exposed to physical stresses which can be extreme in some cases [2].

An "ergonomically correct" working method using optimal load handling procedures [3,4] can reduce the stresses created by patient transfers. Ergonomically correct working is defined as follows: avoidance of prolonged, moderate or extreme, forward or lateral inclination or twisting of the trunk; work as close to the load as possible and avoid positions involving holding, lifting or pulling of high proportions of the load weight; use low finger forces and wrist positions at or near the to the neutral O-position as far as possible. Even when ergonomically correct methods are used, the spinal load in manual transfer of heavy patients can still be in the mid to upper regions of disc compression risk. Availability of mechanical aids like patient lifts would be very helpful in such cases. But, in practice, experience in the intensive care facility in which our investigation took place, reveals a variety of reasons favouring manual transfer. Many of these relate to the type of patient involved – patients in vegetative state. According to the nurses, these have an acute fear of accidents during transfer, which can be aggravated by use of mechanical aids, but mitigated by close body contact.

Consequently, the only remaining way to reduce the risk of work-related health disorders in nurses, even when they are using ergonomically correct working methods, is to improve their physical fitness and minimize age-related deterioration with the help of regular physical exercise [5].

Study Population

Nurses

The study was performed between 2011 and 2014 in the specialist facility for intensive care clinic of Bavaria GmbH in Kreischa/Saxony. It comprised 21 nurses employed there as professionally qualified female nurses, assistant nurses or probationer nurses (female participants only).

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At the time of first registration of personal data most of the nurses included in the study were in the younger age groups (61.9% under 30). The number of older experienced nursing staff was much lower (14.3% over 45). The only professionally qualified nurse in the older age groups was the Charge Sister; all the others were only assistant nurses.

By the time of the second registration of personal data the age structure had undergone some changes. Although the share of this age group was still roughly the same, the size of the under-30 age group had shrunk to 52% and the size of the intermediate 30-45 age group had swelled to 33% following the employment of three new people.

The two most frequently mentioned body regions where the nurses complained of pain or other symptoms at first registration were the lower back and the neck. Over 50% of the study population complained of pain in each of these areas. These findings are comparable with the results reported in other studies. More detailed data on the nurses can be found in our project report [1]. The training courses lasted for five months with two training sessions per week.

The following eligibility criteria had to be fulfilled for inclusion in the study:

- no existing severe acute or chronic disease contraindicating physical exercise;
- voluntary participation in the study during working hours;
- at least one year of professional experience after training in a nursing profession;
- regular manual patient handling.

Patients

The intensive care facility accommodates up to 20 patients who are either in a vegetative state or suffering comparable chronic sickness requiring intensive care. They are housed in two residential wards for seriously sick patients and remain there either for prolonged periods or until death. The patients in vegetative states include adults and teenagers with body weights and sizes similar to adults. All of the patients in vegetative states that have apallic syndromes justifying classification at the highest nursing requirement levels of the Barthel Index (FRB) [6]. This syndrome is characterized by apallic exhaustion or time-of-day-dependent opening of the eyes, spontaneous breathing, and a disoriented sleep-wake rhythm. From a layman's perspective the patients are unresponsive to stimuli, but medical specialists are convinced that they are very probably not 'unconscious'. Their sensory perception is regarded by clinicians as wholly or partially intact. With patience and specific stimuli it is even possible to overcome their passivity in some cases. Key body functions are supported by medical procedures. These include ventilation, aspiration of secretions through a tracheostomy tube, nutrition about the probe and excretion via catheter.

For optimal nursing it is important to remember that the patients might be suffering from one or more of the following physical states:

- lack of body tone;
- spasticity (a motor disorder with increased muscle tension);
- contractures (restriction of joint function or mobility), shrinkage of muscles, tendons and ligaments, stiffness of joint flexors in flexed position and of extensors in extended position, abduction and adduction contractures. Please refer to the Project Report [1] for more detailed patient data.

Methodology

Muscle strengthening and functional training

The Rohmert-Luczak stress-strain-model [7] makes it possible to relate the factors influencing a person integrated into a work system to the effects produced by these factors. The causes are referred to by the term stress, the effects by the term strain. Strains are affected not only by the relevant stresses, but also by personal factors like worker skills, experience and needs. Kenny [5] found that regular physical training counteracts the risk of an age-related decline in work performance and an accompanying increase in work-related health disorders.

The aim of the physical training course used in this study was to improve coordination and enhance spinal stability, both of which are essential to reduce the nurses' health risk during patient transfer. Good coordination is needed to enable quick and correct action and reaction to prevent accidents like falls or collisions. Coordination training aims [8] to:

- enhance coordinative skills like maintenance of balance and speed of reaction, and thereby enable the nurse to learn new and more difficult techniques like, for example, the ergonomically correct methods of transfer mentioned in Section 1;
- harmonize interaction of groups of muscles, different parts of the body and their movements into a fully coordinated structure that maximizes economy of energy and is consequently more efficient;
- remain effective even at advanced age levels and when the subject is learning new or revised techniques, for example, ergonomic techniques;
- avoid accidents.
- Strength training [8] helps to:
- improve personal performance at work and in sport;
- minimize risk of injury (muscles have a protective function);
- minimize risk of undesirable posture (by counteracting atrophy of muscles stabilizing the spinal cord);
- provide compensation training (by strengthening muscles tending to weaken through non-use and also by strengthening antagonists and synergists, thereby preventing development of muscle imbalance).

The training course should aim to produce a steep increase in muscle strength early in the program. This should sink to a flatter level and ultimately to a totally flat line as the course progresses [9]. The training will increase the number and thickness of the muscle fibres [10].

Two specialists in sport science designed this specific course to improve coordination and spinal stability. It is structured as a short warm-up phase followed by the main exercises. It was held in one of the rooms of the ICU facility under the supervision of one of the sport specialists and a physiotherapist. Every effort was made to ensure that each volunteer attended the course twice weekly over a 5-month period, but absences for vacation, free days and night-shift working made this impossible.

To enable voluntary continuation of the training at home, the exercises were designed to be performed without the need for technical aids, either at all or only with cheaply obtainable apparatus like the Theraband Powerstick.

A training manual was also produced to enable volunteers to continue the exercises indefinitely. In addition, the exercises were displayed on a pin board in the nurses' changing-rooms.

Various documents were also circulated to members of the nursing staff to assist them in continuing exercises at home. These explained stretching exercises and exercises for strengthening the trunk muscles.

Training took place in small groups of not more than six volunteers, either immediately after the early shift or before start of the late shift. Training was treated as working time and lasted for approx. 20 minutes per unit. Allowance was also made for changing time. Alternative exercises were also included in the program to introduce some variety and improve performance.

Because time pressure was a major problem, it was decided to introduce some relaxation exercises. These were mostly breathing exercises that could be performed in a sitting position.

Two members of the hospital staff, a physiotherapist and an ergotherapist who were strong supporters of the training course, were encouraged to act as multipliers by explaining the aims of the course to new staff members and ensuring that the newly acquired knowledge of body functions is not forgotten by existing staff.

Detailed descriptions and illustrations of the two warming-up exercises and the seven main exercises were given and followed by display of one of the exercises.

Specimen exercise: Crunches and biceps curls with the Power stick

Starting position:

- supine, knees bent 90°, heels pressing against floor
- feet in the Power stick stirrups
- arms extended, take up slack in Power stick ropes

Exercise:

- lift head and shoulders slightly from floor
- bend arms to pull Power stick toward chin
- look obliquely upward
- hold position for 5 seconds, then revert to starting position

NB.

- Form double chin to raise body tension, pull navel in, tense pelvic muscles, press heels against floor.
- The breastbone (not the head) determines direction of upward and downward movement.
- Breathing: breathe out when lifting head and shoulders from floor, breathe in when returning to supine position.

Stress norms

- Stress intensity: frequency of movement in breathing rhythm; rope setting: blue -black, for higher stress levels tighten ropes
- Stress duration: repeat 8 - 15 times
- Stress extent: 1 - 3 series
- Stress density: 30 sec
- Stress frequency: 1 - 2 times per week

Aims of exercise

- Strengthening of biceps muscles and abdominal muscles

Trunk and body stability test

The computerized MFT S3-Body Stability Test [11] was used primarily to determine balance capability- These tests checked the following items:

- stability (Sureness of stance on a variety of surfaces);
- sensorimotor function (during temporary and reactive restoration of balance);
- Symmetry (weight distribution on variable surfaces).

Stability data makes it possible to draw conclusions on sureness of a person's stance on unstable surfaces and, consequently, on the condition of their bodies' holding muscles. Good body stability protects the spinal cord and the joints as well as counteracting stresses exerted on the body during movement.

In this study the data for sensorimotor regulation capability and body symmetry were determined. The sensorimotor test data shows how quickly and frequently the subject is able to restore his balance on an unstable surface during the test period. The sensorimotor regulation capability test also measures the number and strength of compensatory movements performed.

The symmetry test reveals whether the subject has a preferred weight distribution or whether intrinsic equilibrium exists. The latter is an essential prerequisite for a bearable level of strain on the spinal cord and, consequently, for avoidance of excessive unilateral stresses in the spinal region. Also evaluated were any deviations in sagittal plane during movements involving raising of right/left side or deviations of frontal level during front/back measurement. For this the movement deviations were evaluated from the symmetry plane in the right/left measurement and deviations from the frontal plane in the forward/backward measurement.

The data were tabulated in a stability index and in a sensorimotor index, both of which used a nine-point scale where the minimum value 1 = very good and the top value 9 = very bad. These can be compared with norm values provided by the MFT Academy International 2007).

The computerized Trunk Stability Test using Pegasus-Software [12,13] was used to measure the force profiles of the musculature stabilizing the spinal cord (spinal cord stability). The maximal isometric force of the musculature was determined at three levels:

- abdomen (trunk flexion) and dorsal musculature (trunk extension)
- lateral flexors of the trunk (lateral left/right inclination of trunk)
- rotator muscles of trunk (left/right rotation).

The foregoing groups of muscles bear most of the responsibility for stabilization of the spinal cord on exposure to both static and dynamic stresses.

The body and trunk stability tests were used for the following reasons:

When correctly performed, the nursing work investigated in this study involves physical demands requiring a high degree of coordinating skills. This applies, in particular, to patient transfer work

performed without mechanical aids. Sureness of stance and a well-developed feeling for the human body are extremely important prior to initiation of the turning phase, in order to perform the transfer successfully without any significant use of force and, more especially, without accident. Experience shows that a 2½-week deficit-oriented coordination training course can produce an improvement in sureness of stance [14]. Hollmann found that the higher the level of deficits in a subject, the greater was his gain in proficiency.

Testing and training in coordination make sense, if the objective is to teach nurses sensible ergonomic transfer techniques. If this is the case, it can be expected that the nurses will benefit from lower levels of physical stress in their work and also that absentee levels through sickness will drop.

A well-trained trunk musculature capable of stabilizing the spinal cord is also essential in nursing work, because it can provide protection when the transfer procedure for laying the patient in bed is badly performed, for example, by bending the trunk too far forward over the bed (a forced posture involving a high level of static work for the dorsal musculature). The physical demands on the dorsal musculature are often significantly higher than the nurse's motor capabilities. This results in excessive stresses on the organic structures of the nurse's holding system, especially the inter-vertebral discs – with the relevant consequences.

In order to improve condition of the trunk musculature, it is first advisable to perform suitable tests to determine actual muscle status, both before and during commencement of training specifically designed for strengthening the muscles surrounding the spinal cord. Any such training course must make allowance for the physiological balance between agonists and antagonists. It can be expected that a repeat test will, as with the coordination training, reveal improvements in work performance after only 2 or 3 weeks participation in a suitable training course.

Results

The physical status and the results of the Body Stability Test and Trunk Stability Test of each volunteer were evaluated at the first registration of personal data and then six months later, i.e. 6 months after inclusion of a volunteer in the training course. A total of 10 volunteers took part in the before/after measurements. Natural fluctuation in nursing staff made it impossible to achieve a higher study population. The results of the before/after measurements are presented below (Table 1).

Left/right body stability has shown slight improvement in all but one of the volunteers. This also improves support for the spinal cord during typical transfer movements. All except the three oldest subjects showed improvement in front/back body stability (Figure 1).

Left/right sensorimotor rating has improved in all subjects except one older person who failed to show improvement in all other tests. More than half of the subjects showed improvement in before/after ratings and their results can be classified as good or very good. Before/after sensorimotor ratings for forward/backward movements showed improvement in eight out of ten subjects, but deteriorated in two older subjects (Figure 2).

The training course produced little change in left/right symmetry ratings, but these deteriorated in three subjects Forward/back symmetry also showed little change and deteriorated in in four subjects, Neither of these deteriorations was age-related (Figure 3).

Viewed overall, participation in the training course has produced positive results in most subjects, both in body stability and in coordination of movement (sensorimotor). Only the symmetry ratings, which are important for uniform application of the passive musculoskeletal system, have shown little or no improvement. However, the static tests for body stability left/right (Figure 1) and the sensorimotor left/right movements (Figure 2) did produce significant improvements.

The Trunk Stability Test showed that participation in the training course produced positive results in excess of target ratings in nearly all subjects for the extensor muscles (to the rear) and the flexor muscles (to the front) and also for the muscles governing lateral inclination. The muscles governing left/right rotation also showed before/after improvement (Figure 4).

Thus, it can be claimed that the training course brought positive changes in stability for most members of the study population.

No surveys were performed on the effects of the training course on the general health of the subjects, as it seemed unlikely that any such survey would produce meaningful results in view of the relatively short exposure period. A written survey completed by the subjects highlighted the following positive aspects:

- Sporting activity
- Doing something for one's health during working hours
- Change from the daily routine

Variable	Average	Standard Deviation	T	df	Sig. (2-sided)
Stability Index left / right (Before)	5.00	0.69	3.24	9	0.01*
Stability Index left / right (After)	4.37	1.04			
Stability Index forward / back (Before)	4.83	0.7	0.86	9	0.41
Stability Index forward / back (After)	4.59	1.03			
Sensorimotor left / right (Before)	4.54	0.63	2.53	9	0.03*
Sensorimotor left / right (After)	3.75	1.21			
Sensorimotor forward / back (Before)	3.93	0.55	0.69	9	0.51
Sensorimotor forward / back (After)	3.71	1.31			
Symmetry left / right (Before)	49.1	4.82	-0.87	9	0.41
Symmetry left / right (After)	52.1	10.44			
Symmetry forward / back (Before)	48,70	11,80	1.72	9	0.12
Symmetry forward / back (After)	43,20	12,75			

* p=0.05

Table 1: The results of the before/after measurements.

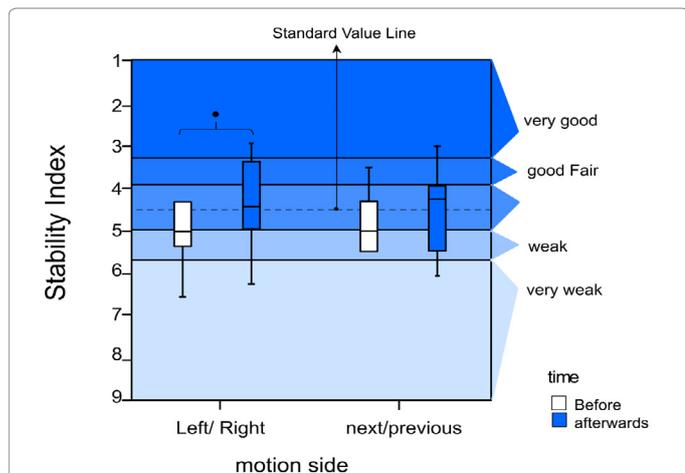


Figure 1: Before/after body stability ratings for left/right and forward/back movements. The traffic-light display is an approximation, and assumes the same standard values for all ages. This is permissible for the subjects in this study, since it is exclusively women in age do not move in the border area (i.e., not younger than 20 years old or older than 60 years)* p=0.05 (N=10).

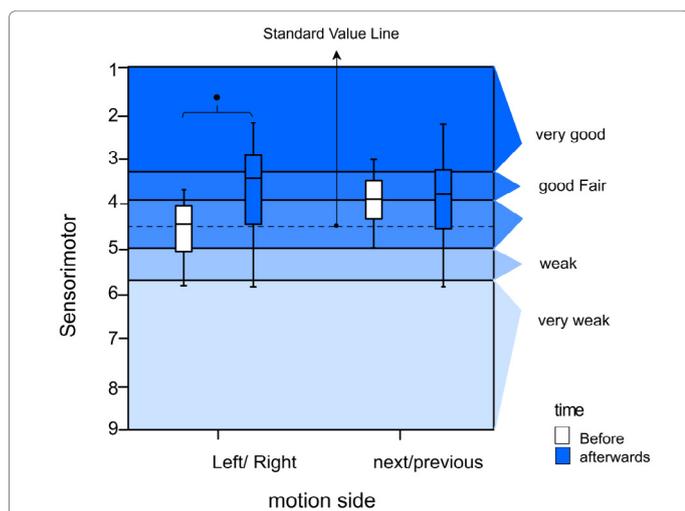


Figure 2: Left/right sensorimotor ratings (relating to body balance) and forward/back sensorimotor ratings before/after training course (n=10).

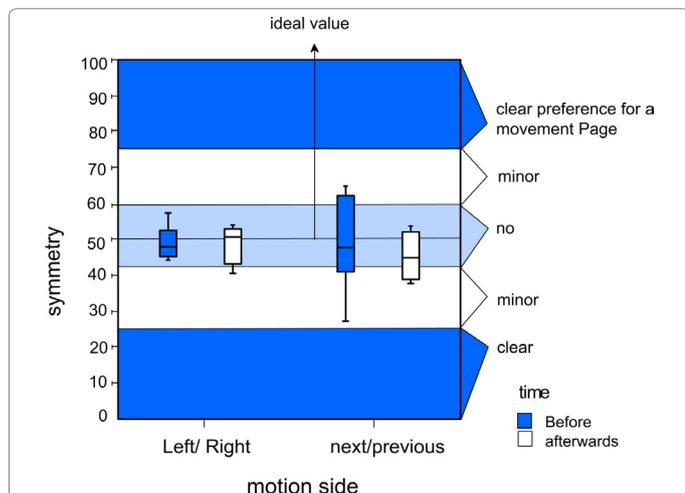


Figure 3: Before/after ratings for left/right and forward/back symmetry (N=10).

- Individual exercises (e.g. exercises for legs and buttocks)
- Encouragement of teamwork.

Discussion and Conclusion

Physical training produced positive effects in coordination capability and spinal cord stability in the majority of the nurses in the study group. These are essential for nurses performing manual patient transfers. No improvement was found for individual criteria in some members of the study group, specifically in one to three of the older probands.

No clear reason for this could be identified. It can only be assumed that they were unable to perform the exercises correctly despite their readiness to take part in the course.

The significant results, especially those for symmetry ratings (Figure 3) could perhaps be explained, firstly, by the assumption that longer duration of the individual exercises was probably needed to obtain (significantly) better results – especially those relating to coordinative demands while working in a standing position, i.e. more time should be invested in improvements in symmetry than in body stability and sensorimotor regulation capability, which itself needs more comprehensive training exercises to improve the results (only 2 of 9 exercises addressed the problem of better coordination in a standing position, i.e. approx. 4.5 min. per training unit; perhaps a third exercise should have been included).

Secondly, by the fact that no correlation could be found for the before/after results of the forward/back measurements at the S3 reliability and objectivity check.

The left/right measurements showed a certain degree of correlation, but this was still significantly lower than the results for the reliability tests for body stability and sensorimotor.

Regulation capability both of the latter items are of great importance for nursing work and, as described above, need to be improved.

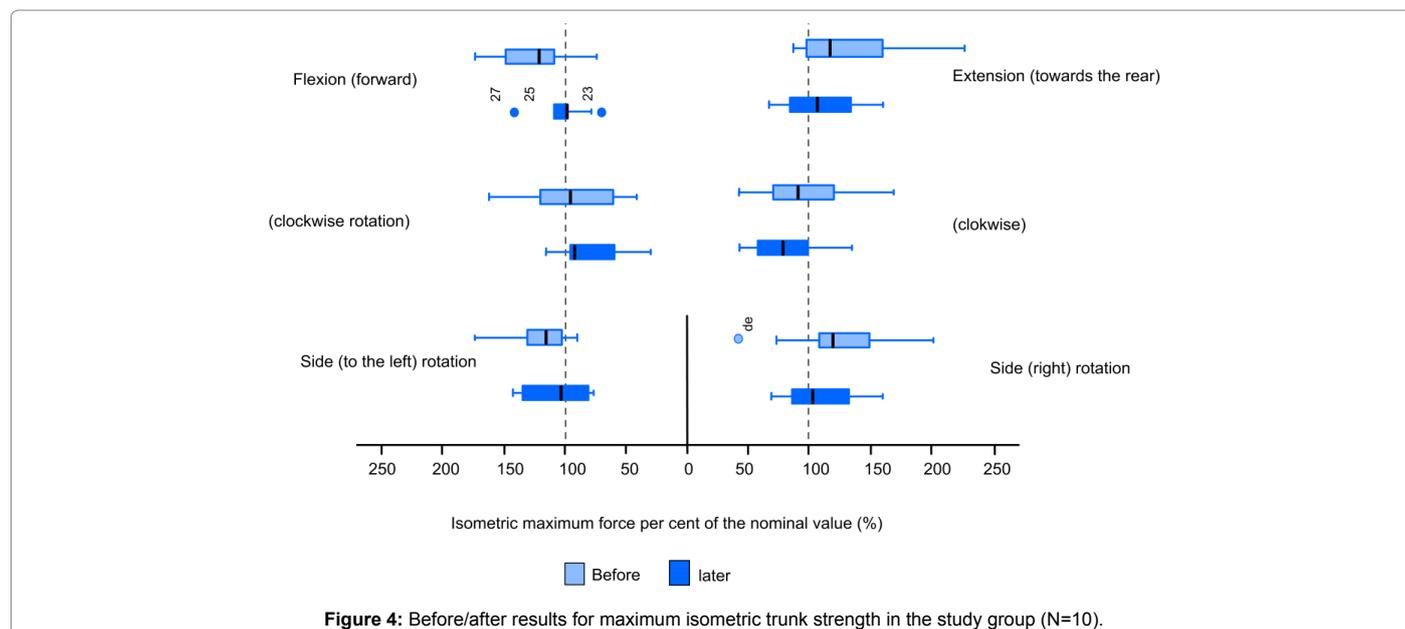
The use of well-trained specialists to supervise the training course was an important benefit.

Another important feature was the decision to hold the course during working hours.

The nursing staff have given some thought to the aims of the project and made the following suggestions for the future:

- The exercises should be integrated into the normal shift routine, i.e. not hung on at the end of the shift or booked as time credits;
- The exercises should continue to be offered to nursing staff as a voluntary option;
- The exercises should be supplemented by massage sessions provided by the hospital’s own physiotherapists.

The importance of physical training courses for nurses suffering from back pain has already been confirmed in earlier studies [15]. Physical training for strengthening muscles and improving functional work should not, however, be used as an isolated activity to optimize stresses arising during patient transfer [16]. In addition to encouraging use of correct ergonomic techniques (which itself normally requires a training program), the possibility of using mechanical aids should be considered- And the need for seminars on good work organization should never be forgotten.



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Reference

- Stern H, Landau K, Diaz Meyer M, Jacobs M, Weißert Horn M (2013) Healthy work Intensive care (GAI) - employability of older nursing staff in the promote intensive care and receive. Project report for Saxon Development Bank, Sponsored by the Free State of Saxony and the European Social Fund. Dresden.
- Landau K, Diaz Meyer M, Weißert Horn M, Jacobs M, Stern H, et al. (2014) To burden and demand patient transfer from Heavy care. In: *Health, social and environmental health* 9: 852-863.
- Landau K, Weißert Horn M, Jacobs M, Stern H (2014) Musculo-skeletal stress When transfer ring totally dependent patients. *J Ergonom Open Access*.
- Weißert Horn M, Diaz Meyer M, Jacobs M, Stern H, Raske HW, et al. (2014) Ergonomically correct operation in the transfer of heavy care. *J Ind Sci* 3: 175-183.
- Kenny GP, Yardly JE, Martineau L, Jay O (2008) Physical work capacity in older adults: Implications for the aging. In *Am J Ind Med* 51: 610-625.
- Mahoney FI, Barthel DW (1965) Functional evaluation: The Barthel Index. State Medical, Maryland.
- Bokranz R, Landau K (2012) Handbook of Industrial Engineering Productivity Management with MTM (2nd edn). 1: 2.
- Weineck J (2010) Optimal training. Physiological performance training theory under special focus on children and youth training. spitta Med Verl ges mbH (16th edn) Balingen.
- Sale DG (1988) Neural adaptation to resistance training, *Medicine and Science in Sports and Exercise* 20: 135-145.
- Fukunaga T (1976) The absolute physical strength and muscle strength training. *Sports doctor. Sports Med* 27: 255-266.
- MFT Academy International (2007) S3 test line, Training manual, Guntramsdorf.
- BFMC (2001) PEGASUS 3-D system user, BFMC Biofeedback. Engine Control GmbH, Leipzig.
- Witt M (2006) PEGASUS, a diagnostic device for detecting the mobility and Strength of the trunk-use as part of the performance diagnosis in DSV. Advice on core stability in DSV, Hamburg.
- Hollmann W, Hettinger T, Strüder HK (2008) Fundamentals of Labor, Training and Preventive Medicine, *Sports Medi* 4.
- Müller K, Schwesig R, Leuchte S, Riede D (2001) Coordination training and Life quality: A Longitudinal study at caregivers With Back pain. *Healthcare* 63: 609-618.
- Jäger M, Jordan C, Theilmeier A, Kuhn S, Wortmann N, et al. (2010) Biomechanical analysis to prevent overloading of the lumbar spine in patients transfers. In *German Society for Occupational and Environmental Medicine, 50th Scientific Conference*.