The ErgoStat Program

Pilot study of an ergonomic intervention to reduce static loads for caregivers

By Amelieke Brinkhoff and Nico Knibbe

ONE IN 10 SERIOUS WORK-RELATED BACK injuries in the U.S. involves nursing personnel, and about 12 percent of caregivers leave the profession because of back injuries. Workers' compensation (WC) costs for back injuries among healthcare workers are an estimated $1.7 billion annually (U.S. DOL, BLS). According to scientific studies, the primary contributors to back injuries are 1) lifting patients and 2) static (positional) stress (Estryn-Behar 47).

To reduce these injuries, healthcare facilities are paying greater attention to physical loads for caregivers. Actions include reduction of dynamic loads caused primarily by lifting and repositioning patients. The use of lifting aids, lifting specialists and training based on a nonlifting strategy that assumes health-based standards for lifting will lead to a reduction in overloading of nursing staff and caregivers (Fragala 23). A study in three British nursing homes showed that an integrated approach to the prevention of musculoskeletal pain among nursing home staff can be effective in the sense that staff exposure to manual handling risks decreases significantly as more tasks are performed safely (Crumpton, et al). Longitudinal controlled research in Dutch homecare facilities subsequently showed that such a program can reduce the number of back complaints and sick leave (Knibbe and Friele 445). Five years later, this reduction has been maintained [Knibbe and Knibbe(c)].

This does not mean that the exposure to physical overload and associated musculoskeletal pain complaints have been reduced to a level that is acceptable from a health perspective, however. Little attention is being paid in typical anti-lifting programs to positional or static loads. These loads are also called covert loads because the load is not visible (nothing is being lifted or pushed), but there is an actual load. These loads can be heavy for two reasons:

1) The weight of the lifter's own trunk, arms and head places a strain on the back, neck and shoulder area; these parts of the body make up about two-thirds of one's total body weight. The more the lifter bends forward, the greater these loads become.

2) Muscles must hold the position assumed by stabilizing the weight of the trunk, head and arms. This requires a great deal of muscle power, which rapidly increases the more the lifter bends forward. If the position must be maintained for any length of time, muscle fatigue can occur quickly. This causes a nagging pain in the back or neck.

Research on static loads in three Dutch geriatric care facilities has shown that caregivers spend 21 percent of their eight-hour working day standing in a bent-forward, twisted position or a bent-forward-and-twisted position (Engels, et al 338). This research also showed that patient bathing and showering tasks, in particular, caused peaks in static loads.

Research has also shown that the type of aid used in bathing and showering patients has a major effect on the eventual static load on the caregiver [Knibbe and Knibbe(b) 37]. The height-adjustable shower chair, still relatively little-used in the healthcare industry, was shown to cause the least physical overload compared to a high-low shower stretcher, a high-low bath or a high-low bed. Using correct lifting aids does not mean, however, that caregivers will automatically use them in the correct manner and that this will, in turn, lead to fewer complaints. In addition, despite the fact that peak loads are experienced dur-

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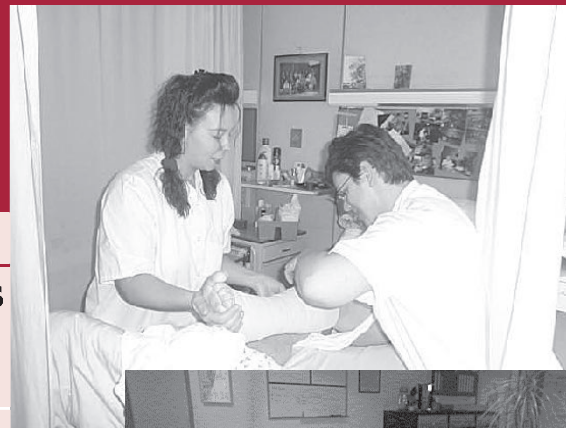
Table 1
OWAS Action Categories

Action Category	Description
AC1	Normal position, no action required.
AC2	Load in this position is slightly harmful. Action to change the position should be taken in the near future.
AC3	Load in this position is distinctly harmful. Action to change the position should be taken as soon as possible.
AC4	Load in this position is extremely harmful. Action to change the position should be taken immediately.



Static loads are not confined to washing, bathing and showering patients. They can also occur when bending over a table to update a nursing file, talking to a patient in a wheelchair, or retrieving medicine and other supplies.

ing hygiene activities, static loads are not confined to washing, bathing and showering patients. They can also occur when bending over a table to update a nursing file, making beds or talking to a patient in a wheelchair. Static loads also occur during tasks not directly related to patients. Such tasks cannot always be improved via an ergonomic intervention and, therefore, require knowledge, awareness, and the correct attitude and skill, which requires training.

Statistics are not available at this time to show the effectiveness of an intervention policy specifically directed at reducing static loads. Therefore, the first goal of this pilot study was to evaluate the ErgoStat program. This program is specifically directed at bringing static loads within health-based limits. The research also assessed the effect of static loads on caregivers while showering a patient on a special type of height-adjustable shower/toilet chair. The height and angle of this device can be adjusted electrically, which means that a patient can be brought from a normal sitting position (with both feet on the ground) to a full lying position at a height selected by the employee. The chair was included in this study as part of the intervention.

Study Method

Before and after tests were designed to measure the effect of the ErgoStat program. The same measuring instruments were used in both cases. The period between measurements was four months. In the intervening period, the ErgoStat program was carried out on a unit in a geriatric care facility. No control group was established. Physical (static) loads were measured using the Ovako Working Posture Analyzing System (OWAS), a widely accepted and reliable observational method for posture analysis. One advantage of the method is that it enables comparisons with previous research in similar settings (Kahru 77). The method is based on multimoment sampling at fixed intervals. In this study, observations consisting of a back score, an arm score, a leg score and an external-weight score were made every 30 seconds. Scores gathered by two observers were fed into a handheld computer. Data were eventually converted into four action categories (AC); each category comprises a particular degree of load on the entire body and makes recommendations for the measures to be taken (Table 1).

During the before measurements, the two observers watched five different caregivers during all of their activities. During the second set of measurements, three of these caregivers were observed again, along with three new caregivers. In total, nine shifts were observed, with each shift divided into three periods (Table 2). This procedure produced a picture of the static loads on caregivers during the entire shift, peak loads and differences in loads among caregivers.

OWAS scores were linked to 10 different groups of activities the caregivers performed during a dayshift; these included "assisting while using the toilet," "patient care" and "social activities" (Table 3). To enable comparison with Engels' 1998 research, groups of activities were defined as similarly as pos-

Table 2

Percentage of Observed Positions in AC1 (Normal Position) Per Observed Period

Period	Before ErgoStat % AC1	After ErgoStat % AC1
1) 7:00 to 9:00 am	57.6	69.6*
2) 9:00 to 11:30 am	67.2	77.6*
3) 12:00 to 3:15 pm	71.0	76.0

*alpha < 0.05

sible. In this way, the tasks that caregivers performed most often, which activity caused the greatest static load and where the greatest benefit could be achieved were mapped.

Study Population

One unit of geriatric care facility was selected for the study. The 150-bed facility adopted a nonlifting policy in 1996 based on a research assessment of dynamic loads within the organization. Lifting aids were used extensively, an active lifting committee was in place and a lifting specialist worked on each unit.

The lifting committee focuses on preventing physical overloading of caregivers. Preventing physical overloading is a complex matter involved in all facets of the organization. This group of experts and decision makers ensures a broad support base for all caregivers and organized attention to the subject. The lifting specialist is an employee who monitors compliance with the nonlifting policy. This person indicates whether work is performed in a safe manner and whether aids are used properly; clears work bottlenecks that lead to physical overloading; and encourages colleagues to work safely.

As noted, five caregivers were selected for observation with the OWAS method. These caregivers were permanent employees; it was expected that they would work during the before and after measurements and could participate in the intervention. All 29 caregivers on the unit participated in the intervention program. The underlying consideration was that the eventual way people work is determined not only by caregiver awareness and attitude, but also by the social norms within the group (Fishbein and Ajzen). For example, it has been shown in practice that using a bed's raising and lowering mechanism is largely socially determined. If the norm on the ward is to start working at a bed by setting it to the correct height, those who work on the ward are encouraged to always do so.

To a large degree, the patient's mobility determines the physical care needed and thereby also impacts the physical loads placed on the caregivers. This is why efforts were made to observe the same patients during both sets of measurements.

The Intervention

Based on the information gathered by the observers during the first measurements, the intervention program was set up in collaboration with the caregivers, the lifting specialists, a physiotherapist and the head of the unit. One basic principle of the ErgoStat program is to provide caregivers with a cue about once a week during the course of the program. These cues can vary widely in nature. They may include tangible cues that when used properly can reduce static loads immediately. For example, a small stool placed on the bed and on which the patient's leg rests allows the caregiver to dress leg wounds without static loads.

Psychological cues that contributed to caregiver knowledge and awareness of working more safely were also used. These included various measures.

- A survey of caregivers was conducted and results presented to the ward.
- Questions were asked to encourage caregivers to think about problem tasks and solutions regarding static loads.
- The ward's lifting specialist led two discussions in the progress meetings based on two propositions. One proposition was: "Caregivers have a very dynamic profession, they are always busy. They therefore have no problems with static loads and it is unnecessary to pay attention to this issue on the ward." The other proposition was: "Physical load is part of the job, and I have choosen this job, so I have to take it [accept the risk] for granted [as part of the job]."
- Caregivers received an informative book that contained basic information about what a caregiver should know about back pain and its prevention.
- All caregivers completed a 30-minute CD-ROM program entitled, "Transfer with Care." It allows the user to teach him/herself in an interactive, self-paced manner. A scientific evaluation among 267 caregivers revealed that the real-life identification with nursing practice (in pictures and video clips) was an important factor for success. The level of knowledge also improved significantly [Knibbe and Knibbe(d)].
- Use of ergonomic aids such as the multipurpose shower chair. The manufacturer of this device conducted two two-hour training sessions on its use.
- A greater number of height-adjustable stools were available for use in patients' rooms.
- All caregivers worked for a day with their backs "strapped" in order to draw their attention to their posture every time they twisted or bent their backs.
- Several caregivers were trained "on-the-job," which means they received advice about working safely from a specialist in a one-on-one situation. After the training, each caregiver received a pen bearing the text: *je lijf is je lief* ("love your body").
- Posters were displayed to illustrate key points. For example, one featured a tall caregiver next to a short caregiver, along with the text: "Set the work up at your own height."
- All caregivers completed a one-day training program on reducing static loads. Actual photos of caregivers in statically overloaded positions were

used. In addition, all caregivers received a rag doll that could be set in various positions; it bore the text: "Bending is polite, but not healthy."

Employee Training

During the training, the caregivers developed a list of tasks that they believed caused physical overloading. They then sought solutions to these tasks among themselves. This intervention was based on the principles of participatory ergonomics (Kogi 1682; Peters 53). Participants learned to regard overloading as a problem within their control. By having them seek solutions, it becomes clear that they also own the solutions. As a result, caregivers become intrinsically motivated to work safely [Knibbe and Knibbe(a) 111].

Several of the caregiver-devised solutions were implemented immediately. For example, the day after training ended, caregivers showered several patients in the evening instead of during the busy morning period. They also devised a different work pattern for disbursing medicines. Previously, one person distributed all medication; this process took two hours and required standing for extended periods. After training, the task was divided between two people.

Other solutions proposed could only be implemented over a longer term due to time and financial constraints. These included clothing design changes (e.g., using gowns with hook-and-loop fasteners to ease patient dressing/undressing, which would impose fewer physical loads); purchasing a work aid that makes the physical load experienced when putting on pressure stockings safe for the caregiver; and enlarging the toilet space by knocking down a wall so that a hoist could be used properly.

Study Results

The primary objective of this study was to gain a quantitative and qualitative impression of the ErgoStat program. Several subjective items were also revealed when observing on the ward. For example, caregivers indicated that they became more aware of their own work practices during the project. Furthermore, once its use had become customary, the multipurpose shower chair was used for other non-intended activities, such as treating feet and lower legs at a working height convenient for the person giving the treatment. Whether these

Table 3

Mean Time Spent on Each of 10 Basic Nursing Activities*

Activity	Percentage of Observations
1) Making a bed with a patient in it	0.1
2) Lifting or moving a patient	4.3
3) Assisting while using the toilet	2.6
4) Transport with a patient in bed or wheelchair, or walking	2.2
5) Patient care (e.g., washing, dressing, medical wound care)	18.9
6) Assisting with eating/drinking or taking medicine	5.5
7) Social activities (e.g., talking, playing games)	8.8
8) Washing/showering (not in bed)	3.4
9) Attendant work and preparations for activities 1 through 3 and 5 through 8 (e.g., housekeeping, getting towels before showering, making beds without patients in them)	32.9
10) Other tasks, mostly administrative	21.4
Total	100.0

**(n = 3,447)*

Figure 1

Percent of Observations in Action Categories in the First & Second Measurements

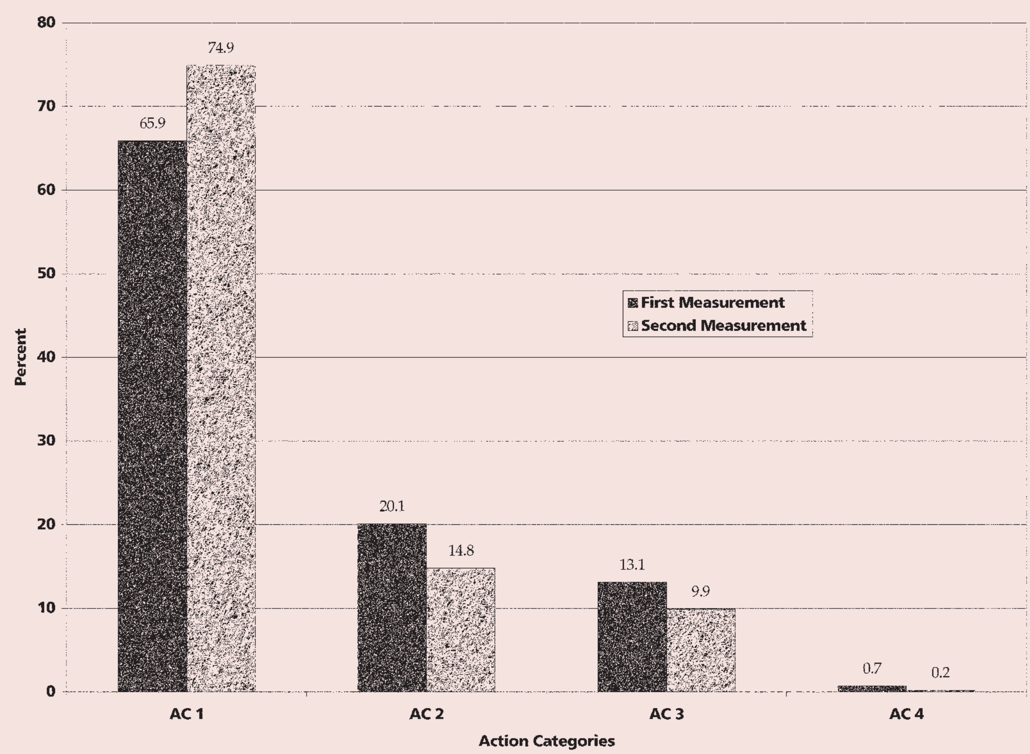


Table 4

Percentage of Observations Indicating Time Spent in Different Working Positions

Working Position		First Measurement n = 3,447	Second Measurement n = 3,292
Back	1) Straight	62.5	73.1
	2) Bent	24.9	21.0
	3) Straight and twisted	4.1	2.9
	4) Bent and twisted	8.4	2.9
Arms	1) Both arms below shoulder level	98.3	98.7
	2) One arm at or above shoulder level	1.3	1.2
	3) Both arms at or above shoulder level	0.4	0.2
Legs	1) Sitting with legs below buttock level	21.7	23.0
	2) Standing with both legs straight	32.0	37.5
	3) Standing with one leg straight	28.9	23.4
	4) Standing or kneeling with both legs bent at the knee	2.6	2.5
	5) Standing or kneeling with one leg bent at the knee	0.4	0.2
	6) Kneeling on one or both knees	1.0	0.7
	7) Walking or moving	13.3	12.7
Head*	1) Free	54.0	71.2
	2) Bent forward	20.3	15.0
	3) Bent to one side	0.6	4.2
	4) Bent backward	4.8	1.2
	5) Twisted	20.2	8.4
Load	0-10 kg	98.5	99.3
	10-20 kg	0.5	0.4
	> 20 kg	0.9	0.3

**alpha < 0.01*

"subjective data" actually led to a reduction in static loads on the body is revealed by the OWAS scores.

Activities Performed

All activities performed during one dayshift were grouped into 10 categories. Doing so provided a picture of which activities occurred, how often and for how long during a shift (Table 3).

OWAS Scores

A total of 3,447 OWAS scores were recorded during the first measurement, and 3,292 during the second. At the time of the first measurement, 33.9 percent of the scores were categorized in AC2, 3 or 4. During the period in which the ErgoStat program was conducted, static loads fell significantly (alpha <0.05) from 33.9 percent to 25 percent (Figure 1). These results showed that healthy positions were being assumed more often after the intervention than before it. The remaining questions were whether improvements were seen with particular parts of the body; with particular activities; with particular periods; with particular caregivers; or with particular patients; and whether there were any differences in using the multipurpose shower chair.

Static Loads & Parts of the Body

The OWAS ACs can be decoded to provide insight into the static loads on the various parts of the body. Table 4 shows the percentage of observations for which a particular part of the body was held in a particular position. It shows that differences between the before and after measurements are particularly noticeable with respect to positions of the back and the head; however, a significant difference can only be seen with respect to the position of the head. In the before tests, the head was held in a neutral, healthy position 54 percent of the time; this rose to 71.2 percent (alpha <0.01) after the intervention.

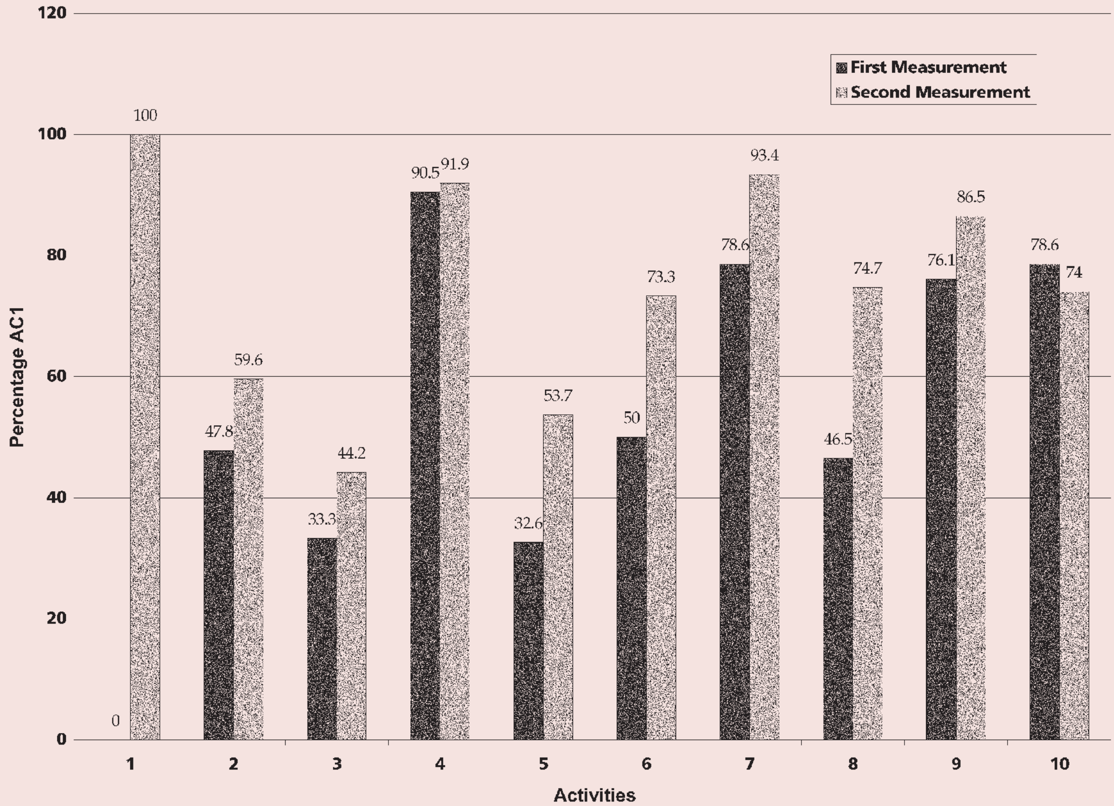
Considering the differences in measurements, it was noticeable that the caregivers did not seem to have lifted at all. This does not mean that no transfers were performed, because 4.3 percent of the time was spent performing transfers (Table 2). However, according to the observers, the caregivers seldom actually lift a load during patient transfers due to compliance with the unit's nonlifting policy. For caregivers to provide a reasonably reliable estimate of the actual transfer load and to enable choices about the optimum patient transfer method, the Dynadisc was used [Knibbe and Knibbe(d)]. Based on calculations made using the revised NIOSH equation for the manual handling of loads, it indicates whether a hoist should be used (Waters and Putz-Anderson).

Static Loads & Activities

The next consideration was whether the improvement in positions occurred with certain activities. Figure 2 shows (for each activity) what percentage of caregivers worked in a healthy position (AC1). What can first be deduced from the figure is that, except for the tenth activity (administration), a percentage increase was seen in the time caregivers spent working in a healthy position. This is particularly true for activities 5, 6 and 8, but only for activity 5 (direct patient care) can a significant increase in healthy working positions be seen (alpha <0.05). When these findings are combined with the data from Table 2, it

Figure 2

Percentage AC1 Scores in Relation to Activities*



becomes clear that the largest beneficial effect on healthier working was achieved for activity 5, which consumes a large proportion of work time.

Static Loads & Observation Periods

The next question was whether improvements occurred during certain periods of the shift. Table 2 shows static loads divided over three periods in the shift in terms of the percentage of working time in AC1. The lowest AC1 percentages (i.e., the most static overloading) were recorded during the morning period (alpha <0.01). A significant improvement in positions was seen during the early morning (7:00 to 9:00) and during the late morning (9:00 to 11:30) (alpha <0.5). This fits with the earlier results which showed that the most benefit was gained in activity 5 (patient care). These tasks—which include washing, showering and dressing patients; dressing wounds; assisting with transfers in bed or to the bathroom; and serving breakfast—are performed mainly during the busy morning period.

Static Loads & Caregivers

The researchers also wondered whether the improvements occurred among certain caregivers, which required determining to what extent static load is associated with the individual. Three caregivers were working at the time of both measurements, so the researchers first evaluated whether the reduction in static load as measured after the intervention could be explained by replacing caregivers with poor skills by those with proper skills. This did not seem to be the case. The improvement of the replaced caregivers was similar to that of those who were incorporated in both measurements.

To make reliable interindividual comparison, comments about the differences between the before and after measurements can only be applied to the three caregivers. Figure 3 shows the times when these caregivers worked in a healthy position (AC1). During the first measurement, Nurse H worked the most time in AC1 on average, followed by Nurse K and Nurse A (alpha <0.01). During the second measurement, an increase in AC1 was found for all three, with the differences (alpha <0.01) and the sequence remaining the same. The increase was greatest for Nurse H, which was taken as an indication that static loads and the degree to which people responded to the intervention were determined individually to a certain extent.

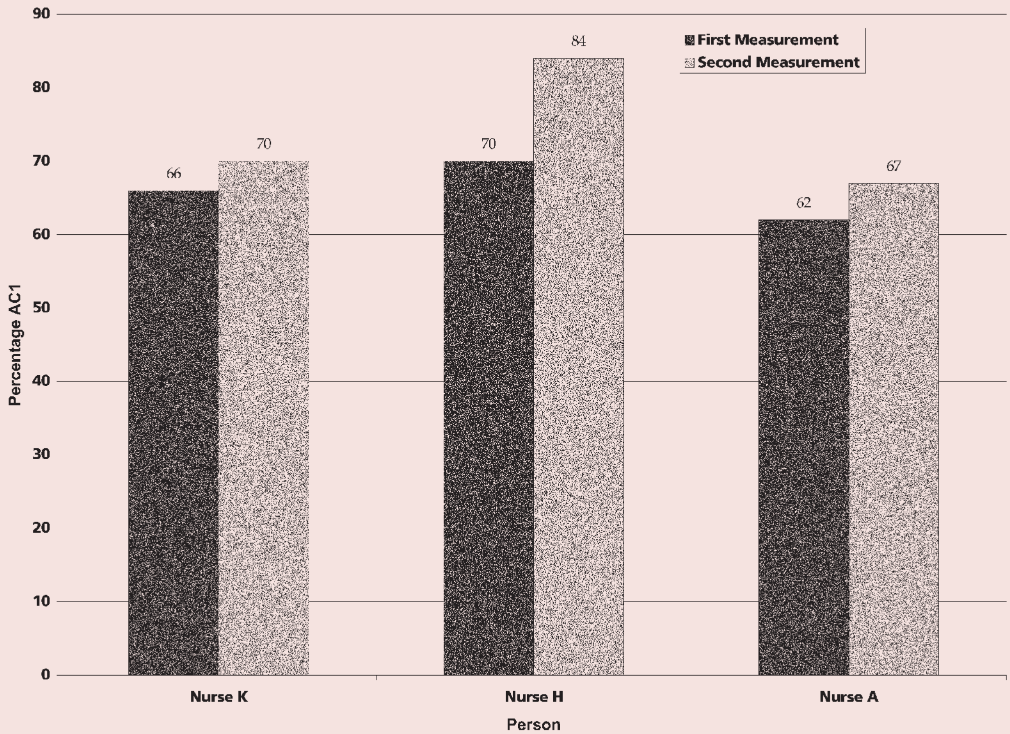
This conclusion agreed with results from previous research into static loads in nursing practice [Knibbe and Knibbe(b) 37]. This study revealed that the harmful load has a clear relationship with the caregiver (e.g., height, preferred position, working speed). As far as the amount of time taken to complete nursing tasks, it was determined that 43 percent of the variation in that time can be explained by the "caregiver" factor. Only 16 percent could be attributed to the type of equipment used (e.g., shower chair, shower trolley, high-low bath, high-low bed) and even less (0.2 percent) was related to the "patient" variable (mobility). Therefore, the results suggest that the cues given to prevent physical loads should mainly be tailored to the individual caregiver. It can, therefore, be assumed that the best results can be expected from individual caregiver training on the job.

Static Loads & the Patient

The researchers also planned to evaluate the extent to which improvements occurred during care for particular patients; this was taken into account when designing the research. However, it was not possible—for practical reasons—to observe the same patients during both the before and after measurements. Consequently, insufficient data were available from observed caregivers performing the same activities on the same patients at the same times both before and after the intervention. Although such

Figure 3

Percentage Observed Positions in AC1 (Normal Position) for Three Nurses



analysis would be advantageous, it should be noted that according to one laboratory study, the harmful load on the caregiver's back had no clear relationship with the amount of patient cooperation [Knibbe and Knibbe(a)]. Furthermore, nothing indicates that the patients being cared for during the first measurement differed with respect to care burden from patients in the second measurement.

To prevent such a practical problem in subsequent research, patients should be classified according to their mobility. The Residents Assessment Instrument developed originally in the U.S. (adopted by Medicare and Medicaid facilities) and the Residents Gallery linked to it (Knibbe, J.J., et al) provide useful tools for patient classification. This is useful not only in nursing practice in order to make care plans more comprehensive and patient-specific through improved patient assessment, but also in scientific research (Crumpton, et al).

Static Loads & the Multipurpose Shower Chair

Despite the fact that the improvements in positions during activity 8 (washing, showering and bathing outside the bed, using hygiene equipment) were not statistically significant, a substantial percentage difference was found. The percentage of AC1 positions increased from 46.5 percent to 74.8 percent. It is, therefore, beneficial to compare this result with previously published research in which static loads were measured during washing a patient using different types of aids [Knibbe and Knibbe(b) 37]. In that study, an AC1 percentage of 58.8 was measured for a standard height-adjustable shower chair, while caregivers using the multipurpose shower chair included in the current research stand in an AC1 position 74.8 percent of the time. The researchers recognize that it is risky to compare these figures—especially since working with different patients and different caregivers makes statistical tests impossible. Still, the wide difference between static loads is food for thought.

Discussion

The OWAS method was used to study the effects of an ergonomic intervention directed at the static loads on caregivers during their daily tasks. The research was not designed to use a control group. In theory, it is not expected that a group without the ErgoStat program would change anything with respect to static loads. Nevertheless, a control group should be included in the design of subsequent research. This present research can, therefore, be classified as an intensive pilot study.

Since the OWAS method is labor-intensive, a relatively small number of caregivers were observed. Consequently, the results could be more dependent on coincidental factors than would be true had more caregivers been included. As a result, generalization to other situations and persons remains open to debate. However, using this method means that a large amount of data was collected, meaning statistical analyses could be performed reliably.

In the scope of classifying this study as a pilot, data were collected only during the dayshift. Different activities were usually performed during the evening and nightshifts, with different staff being present and peak loads occurring at different times in the shifts. It is recommended that these data be collected during a subsequent study so that the problems which occur during those shifts can be identified.

The ErgoStat intervention is intensive. It is a mixture of different cues and reminders communicated to caregivers using various media. The fact that a pilot study was being performed and that caregivers were being observed should not be ruled out. It is impossible to determine what element—or synergy between several elements—from the intervention had a particular effect on the final result. Although indications suggest that individual on-the-job training in particular can be expected to have an effect, statements can only be made about the effect of the intervention as a whole. On theoretical grounds, it can be said that repeated communication of the same message in different modes (e.g., in a booklet, through individual training, via CD-ROM) does have a synergistic effect on the final result.

The duration of the program is also relatively short. Although the results are positive in the short term, no insight can be offered regarding developments in the long term. Because the program is interactive, tailored to caregiver needs and driven by them, it is hoped that the results will continue. Furthermore, because the program is driven by participants, they came to own the problems and the solutions, and were empowered to take action. This allowed caregivers to protect their own health, interwoven as far as possible with caring for patients (Engels). It is important to remember that patient welfare is a powerful motivator as well (Hersey, et al). In any case, long-term evaluation of ErgoStat is required.

This particular intervention does not lend itself to being copied in detail and being executed in other healthcare facilities. The concept can, however, serve as a successful example for intervention programs directed at static loads in healthcare. The stimuli selected must match the employees' level of knowledge, the environment and the organization's culture. Considering that different problems can occur in other facilities and that other caregivers will be driving the program, the content will always be different, which is a condition for success.

Conclusion

The intervention detailed was specifically directed at bringing static loads within health-based limits. The static load on the caregivers' musculoskeletal system was measured before and after the program using OWAS. Despite the methodological limitations, it was determined that the program was beneficial. After the intervention, a significant increase was observed in the percentage of time that caregivers spent working in a healthy position. The most noticeable improvement was seen in performing direct care tasks—demonstrated in particular by an improvement in head position. This benefit appeared to be associated with the individual. Not all caregivers were affected by the program to the same extent.

Recommendations

Based on this study, the following recommendations are offered for an intervention program designed to prevent static overloading in geriatric care:

•Combine software (e.g., training, guidance) with hardware (e.g., height-adjustable equipment).

•Avoid peak loads during the busy morning period by spreading relatively heavy tasks (e.g., showering and bathing) throughout the day.

•Use a broad, creative mixture of interlinked cues that convey the message in an appealing way.

•Make the ergonomic intervention program strongly participative, tailored to caregiver needs and driven by them.

•Pay particular attention to the position of the head as well as to direct care activities (e.g., washing, dressing, caring for medical wounds)

•Ensure sufficient individual attention and on-the-job training. ■

Because the program was driven by participants, they came to own the problems and the solutions, and were empowered to take action.

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