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ORTHOSTATIC TOLERANCE TRAINING OF STROKE PATIENTS IN GENERAL MEDICAL WARDS

An Experimental Study

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ABSTRACT. In order to initiate early activation and counteract the negative effects of bed rest, 71 patients acutely admitted to hospital with a confirmed stroke were randomized to either training or control wards. Sixty-three persons participated in a first orthostatic tolerance test on days 5–7 after admission, which was replicated on days 10–12. A third test was performed three months later. Regular stand-ups were initiated on days 1–2 after admission to hospital and were continued for 1–2 weeks. The trained group had a lower increase in heart rate during tilting and a lower proportion of severely disabled patients on days 5–7 compared with the control group. This difference was statistically significant but cannot be proved to be a result from the regular stand-ups. Still, this minimum type of early activation can be recommended for acute stroke patients, mainly those with a cerebral infarction, who are able to cooperate with the nursing staff.

Key words: bedrest, cerebrovascular disease, disability, early mobilization, nursing care, orthostasis, rehabilitation, tilt tolerance.

Early activation is one of the most important concepts in modern stroke therapy (6, 8, 13). 'Activation' can be defined as 'encouragement to perform purposeful movements, aimed at stimulating the physical, mental, and social ability to perform the activities of daily living (ADL) independently'. 'Early' can be defined as 'within 48 hours after being put into the hospital bed', since most of the negative effects of bed rest will be displayed within that period of time (4, 10).

Bed rest is known to produce impaired orthostatic tolerance (3, 7) as well as other circulatory, respiratory, metabolic, and mental effects (2, 5), and it has been shown that standing up regularly counteracts most of these effects (2, 9).

In stroke units, early activation is initiated by a staff which is specialized and committed to rehabilitation of stroke patients. However, most patients with a history of stroke are treated in general medical wards by a staff which is expected to care for many other categories of patients, too. This involves a risk that the activation process will be initiated several days after admission to the hospital, that the patients will lie in bed or sit in a chair for many hours a day waiting for rehabilitation or long-term care.

This article describes a simple method for early activation by orthostatic tolerance training and exemplifies the method by presenting the results from an experimental controlled study in general medical wards. The hypothesis was that regular standing up from day 1 or 2 after admission to the hospital would improve not only orthostatic tolerance but also the level of functional ability, measured as ADL performance.

METHODS

This study was carried out at the Department of Internal Medicine, Enköping Hospital, Sweden, which serves an area of 48 000 inhabitants. The stroke incidence is 240 per 100 000 inhabitants and year and 87 % of the patients are admitted to the Department of Internal Medicine. There are two wards with 30 beds each for acute medical care and they alternate in admitting patients every other day.

Both wards had an equal number of staff except for an extra registered nurse on one ward. Her most important task was to follow the stroke patients very carefully and facilitate and follow up their transfers between hospital departments or to their own homes. On both wards, the nursing staff and the physician met with the physiotherapist, the occupational therapist, and the social worker once a week in order to plan the care and the discharge from the hospital.

All patients who were consecutively admitted to the medical department with an acute history of stroke from the 1st of January 1987 to the 30th of June 1988 were included in the study. Social and demographic data were recorded at admission, and the medical diagnosis was verified by CT in most cases and by autospy when death occurred.

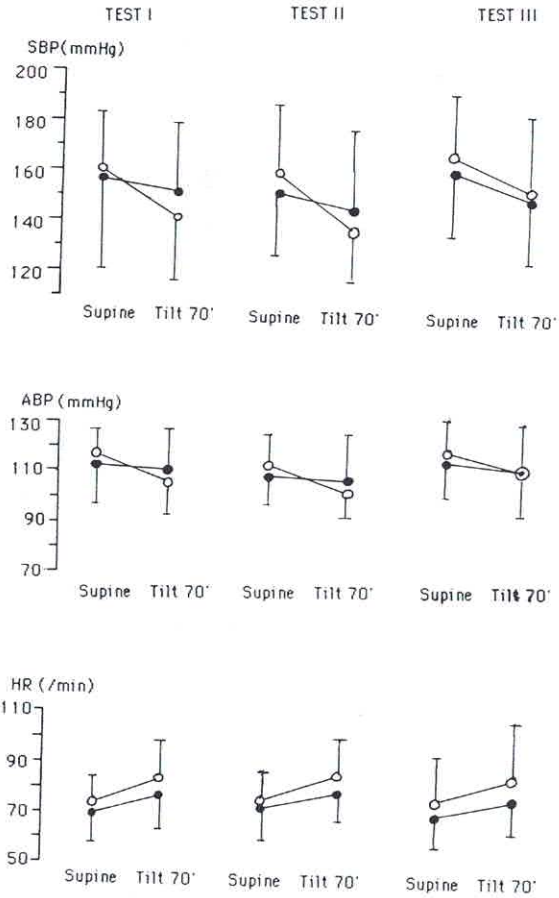

Fig. 1. Change in systolic blood pressure (SBP), artery blood pressure (ABP), and heart rate (HR) in the trial group (●) and in the control group (○).

The ward with the contact nurse was designated for the trial and the other ward for the control. Every patient who was admitted to the trial ward and who had none of the exclusion criteria—1) unconscious, 2) unable to stand on their feet, 3) acute heart disease, 4) other life-threatening disorder apart from stroke—received a training schedule from the day after hospital admission.

The patients were informed about the purpose, namely that of avoiding the negative effects of bed rest, especially orthostatic intolerance, and it was emphasized that the patients could refuse to participate just as they may refuse any other therapy offered.

The patients who agreed to participate were encouraged by the contact nurse and by the rest of the staff to leave the bed or the chair and to stand up at least once every hour from eight o'clock in the morning until eight o'clock in the evening. Every stand-up was documented in the schedule by a signature of the patient or of the assisting staff.

The patients on the control ward had no special contact nurse and no special schedule to follow, but other nursing and rehabilitating activities were the same as on the trial ward. It was not possible to record every change in body position or every activity carried out by the patients.

Orthostatic tests were carried out by means of a tilt table at a tilt angle of 70° on three occasions: on days 5–7 (Test I), on days 10–12 (Test II), and three months (Test III) after hospital admission. Heart rate was measured from electrocardiogram in horizontal position after rest until stable recordings were obtained, and then every second minute during six minutes of tilting. In patients with arrythmia, like atrial fibrillatio, a long recording of 30 cm was measured.

Blood pressure was measured from a three-channeled mercury manometer in the right arm and at the same moments as the heart rate. Mean artery blood pressure (ABP) was calculated from the following formula

$$\text{ABP} = \frac{S-D}{3} + D,$$

where S=systolic blood pressure and D=diastolic blood pressure.

All tests were carried out in the morning before breakfast by trained staff, and no drugs were given until the test was finished.

Comparisons were made using Student's t-test for independent means. Differences were considered statistically significant for p values less than 0.05.

Independence in performing ADL was assessed by means of Katz' Index of ADL (12) by licensed practical nurses at noon on the test day. Six activities, namely, bathing, dressing, going to the toilet, transferring, continence, and feeding are assessed, and dependence or independence in performing the activities is summarized into a cumulative scale from grade A to grade G. Grade A is the most independent grade, and grade G the most dependent It has been shown that the instrument is reliable and valid in acute medical care with nurses as observers (1).

It has also been shown (11) that the ADL grade on days 5–7 after stroke will prognosticate survival or death and discharge within four weeks to own home or a longer hospital stay. The level of statistically significant difference between the two groups as regarded the proportion of severely disabled patients was measured by means of a Chi-square test.

MATERIAL

From the 1st of January, 1987, to the 30th of June, 1988, 169 patients were admitted to the Department of Internal Medicine, Enköping Hospital, due to an acute stroke. Eighty-six of them were admitted to the trial ward and 83 to the control ward. Forty-two percent in each ward had no exclusion criteria and were included in the study.

Thirty-six patients started the orthostatic tolerance training in the trial ward. The training started on day one or two after the diagnosis of stroke, and was continued for 5–7 days, that is, until the first orthostatic tolerance test. If the patient stayed longer at the hospital the training was continued until the second test (10–12 days).

Six patients in the trial ward could not be followed up; three because of death about two months after stroke, and three refused to participate in the third orthostatic tolerance test. In the control ward, two patients were not followed up;

Table I. *Distribution of patients by social and medical characteristics in the trial ward (T) and in the control ward (C)*

Characteristics	T ($n=30$)	C ($n=33$)	Total ($n=63$)
75 years of age or older	15	16	31
No. of men/women	15/15	22/11	37/26
Type of stroke			
Cerebral hemorrhage	1	2	3
Cerebral infarction	21	24	45
Unspecified	8	7	15
Previous diseases			
Stroke	5	8	13
Atrial fibrillation	6	7	13
Hypertension	15	15	30
Diabetes mellitus	9	7	16
None of these	8	9	17

one patient died after about two months and one had to have a leg amputated.

Thirty patients on the trial ward and 33 patients on the control ward participated in the first and the third of the three tests. Twenty-eight and 30 patients, respectively, participated in the second test, which was meant as a test of the reproducibility of the first test.

In the trial ward, one patient had already been discharged before the second test, and one patient had a heart attack on day 10 and could therefore not participate. She recovered and both of these patients participated in the third test. In the control ward, two patients were discharged before the second test and one patient got a back ache. These three patients also participated in the third test.

Table I shows the distribution by age, sex, type of stroke, and other concurrent chronic diseases. The two groups were similar as to age, with a range of 45–86 years in the trial ward and of 52–92 years in the control ward. There was a higher proportion of men in the control ward group. The diagnosis of stroke was verified with CT in 70% of the cases, and most of the patients had cerebral infarctions.

There was no statistically significant difference between the two groups as regards their medical status at admission as is shown in Table II (unconsciousness, disorientation, bladder control, hemiplegia dexter or sinister, aphasia, dysarthria).

At both Tests I and III, ten patients at the trial ward and eleven at the control ward had digoxin. Eight patients at the trial ward and seven at the control ward had other types of antiarrhythmic drugs at Test I, and nine patients in each of the two groups had this type of drugs at Test III. No one received their medication until after the orthostatic test was performed.

RESULTS

Fig. 1 shows the mean systolic blood pressure (SBP), the mean artery blood pressure (ABP), and the mean heart rate (HR) in supine position and during 70° of tilting in the first, second, and third orthostatic tolerance test. Table III gives the results with standard deviations. The results of the first test were reproduced in the second test.

There were no statistically significant differences between the trial group and the control group as regards blood pressure and heart rate in supine position. During tilting, the trial group had a more limited fall in blood pressure, especially in the first two tests. The differences between the mean blood pressures were not statistically significant due to wide standard deviations.

In order to analyze the result more closely, the

Table II. *Medical status in the trial group (T) and in the control group (C) at admission to hospital*

Status at admission	T ($n=30$)	C ($n=33$)	Total ($n=63$)
Disorientation			
Yes	1	2	3
No	29	31	60
Incontinence			
Yes	3	6	9
No	27	27	54
Hemiparesis			
Right arm	20	20	40
Right leg	20	22	42
Left arm	20	21	41
Left leg	21	21	42
Aphasia	5	8	13
Dysarthria	12	14	26

Table III. *Difference in mean systolic blood pressure (SBP), mean artery blood pressure (ABP) and mean heart rate (HR) (±SD) in the three orthostatic tolerance tests in the trial group and in the control group*

	Trial group			Control group		
	Supine	Tilt 70°	Diff.	Supine	Tilt 70°	Diff.
Test I	$n=30$			$n=33$		
SBP (mmHg)	158 (±29)	150 (±30)	−8	160 (±23)	141 (±25)	−19
ABP (mmHg)	110 (±16)	109 (±16)	−1	113 (±11)	105 (±14)	−8
HR (/min)	67 (±12)	74 (±14)	+7	71 (±11)	83 (±14)	+12
Test II	$n=28$			$n=30$		
SBP (mmHg)	152 (±28)	145 (±30)	−7	159 (±25)	137 (±24)	−22
ABP (mmHg)	107 (±13)	105 (±16)	−2	110 (±11)	102 (±14)	−8
HR (/min)	70 (±14)	78 (±15)	+8	72 (±11)	86 (±14)	+14
Test III	$n=30$			$n=33$		
SBP (mmHg)	163 (±27)	151 (±29)	−12	166 (±24)	152 (±29)	−14
ABP (mmHg)	113 (±15)	109 (±16)	−4	115 (±13)	109 (±17)	−6
HR (/min)	69 (±15)	77 (±16)	+8	75 (±19)	86 (±21)	+11

mean falls between the supine and the tilted blood pressures were studied for those patients in both of the groups who had a fall in blood pressure during tilting. Table IV shows these data with standard deviations. There was a statistically significant difference in the mean fall in systolic and artery blood pressure in the second test between the trial and the control group.

The control group had a higher rise in heart rate during tilting than the trial group (Table III). The difference was statistically significant and varied from a p value of <0.01 in the first test ($z=2.6$), to a p value of <0.02 in the second test ($z=2.1$) and to a p value of <0.03 in the third test ($z=1.9$). This means that the difference in orthostatic tolerance between the two groups was most obvious during the first two weeks after stroke and then decreased.

The number of patients who had digoxin and/or other antiarrythmic drugs at Tests I and III showed that the two groups were similar in this respect.

Table V shows the distribution of patients in the two groups by ADL grade and the change from the

Table IV. *Mean fall (±SD) in systolic blood pressure (SBP) and artery blood pressure (ABP) for patients with falling blood pressure during tilting in the trial group and in the control group*

	Trial group		Control group		
	n	$\bar{x}$ (SD)	n	$\bar{x}$ (SD)	p value
Test I					
SBP	$n=19$	17.5 (±12.3)	$n=31$	21.5 (±12.6)	NS
ABP	$n=17$	9 (±5.0)	$n=27$	10.1 (±7.0)	NS
Test II					
SBP	$n=18$	11.4 (±11.6)	$n=26$	27.0 (±13.2)	<0.001
ABP	$n=13$	7.5 (±5.5)	$n=22$	12.5 (±7.2)	<0.02
Test III					
SBP	$n=23$	14.5 (±13.4)	$n=24$	22.1 (±21.7)	NS
ABP	$n=18$	8.1 (±6.7)	$n=21$	12.8 (±9.8)	<0.04

Table V. *Distribution of patients in the trial group and in the control group by ADL grade and change in ADL from days 5–7 (Test I) to 3 months (Test III) after stroke*

	Trial group		Control group	
ADL grade	Test I *n* (%)	Test III *n* (%)	Test I *n* (%)	Test III *n* (%)
A	13 (43)	22 (73)	11 (33)	23 (70)
BC	3 (10)	3 (10)	1 (3)	2 (6)
DE	8 (27)	3 (10)	4 (12)	3 (9)
FG	6 (20)	2 (7)	17 (52)	5 (15)
Total	30 (100)	30 (100)	33 (100)	33 (100)

first to the third test, that is from day 5–7 to 3 months after stroke. The number of severely disabled patients (ADL grades F and G) was three times higher in the control group than in the trial group even on days 5–7 after stroke. The proportions were the same on days 10–12 after stroke. Even if the three most disabled patients in the control group were excluded in order to get equal numbers of patients in the two groups, there were more than twice as many severely disabled patients in the control group. The difference between the two groups as regards the proportion of patients in grades F–G was statistically significant, with a p value of <0.01.

Three months after stroke, the proportions of grade A patients were similar in the two groups, but there was still a higher proportion of more disabled patients in the control group, although the difference was not statistically significant.

In the medical department, the length of stay was the same for each group: a mean of 21 days and a median length of stay of 14 days (range 6–79 days in the control group and 6–119 days in the trial group). Twelve patients in the control group were transferred from the medical department to a geriatric rehabilitation department compared with only 4 patients in the trial group. When the total numbers of days in hospital were summarized, the control group had a median of 20 days (range 6–248) and the trial group a median of 16 days (5–299).

DISCUSSION

A rehabilitation program starts with careful assessments of medical diagnoses and of physical, mental, and social abilities, which form the basis of an individual rehabilitation plan. Such careful assessments take time, and there is a risk involved, namely, that the initiation of rehabilitation in acute medical wards will be delayed.

The early-activation method described in this article aims at utilizing the first days after the medical diagnosis of stroke for counteracting the negative effects of bed or chair rest and to give the rehabilitation "a flying start".

Since there is a potential danger in activating this category of patients, it seemed important to make a randomized controlled study on this method. The way of randomization to either a trial or a control ward can be questioned, but it would have been impossible to separate trial patients from control patients within the same ward. Furthermore, the staff was already before this experiment encouraged to activate the patients as much as possible, and there was a great chance that we would not find any differences at all between the two wards.

The exclusion criteria were well defined in order to avoid possible harmful effects: patients with different degrees of unconsciousness or with acute heart diseases, patients who could not or who would not stand on their feet even when they were supported by the staff.

The two groups were found to be similar as to social and medical characteristics, although there were more men in the control group. This could have implied that they had wives at home taking care of them, which could have shortened their median length of stay, but the median length of stay in the acute medical wards was exactly the same.

The proportion of patients who could participate in the first orthostatic tolerance test was also the same in both wards, 42%. This means that the healthiest (who were discharged from the hospital before days 5–7

after stroke) and the sickest patients (who either died before days 5–7 or who had any of the exclusion criteria) were never included in the study. Patients with intracerebral hemorrhage, for example, were very few, showing that most of these patients were either too healthy (?) or too sick to participate in this type of early activation.

The medical and nursing procedures were the same in both wards and the number of staff was the same, except for the contact nurse in the trial ward. She helped the nursing staff to initiate the stand-up training scheme and observed if there were any harmful effects.

The three orthostatic tests were carried out in a standardized manner, and the reproducibility between the first and the second test was high. The orthostatic tolerance tests showed that the trial group who had been trained by standing up regularly had a statistically significant better orthostatic tolerance than the control group.

Most impressive was the difference between the two groups as regards the proportion of severely disabled patients. The difference cannot be explained either by differences in the patients' medical status at admission to the hospital or in the assessment procedures at the two wards. Katz' Index of ADL has been shown to be reliable and valid in acute medical care with licensed practical nurses as observers (1), and the staff has used the instrument for ten years. Furthermore, the difference in ADL grade between the trial and the control wards was confirmed by the greater number of transferrals from the control ward to the geriatric rehabilitation department and by the longer hospital stay in total for the control group.

Dependence on another person in performing daily activities can be due either to physical disabilities (hemiplegia etc.) and/or to psychological factors (disorientation, lack of motivation etc.) and/or to social factors (environment, rules etc.). Thus, if the two groups were similar as to physical and psychological abilities, it can be supposed that the staff who had seen the stroke patients stand up regularly from days 1 or 2 after admission to the hospital were more inclined to permit or encourage the patients to perform independently in other important activities as well. Such a positive attitude towards early activation is known to be beneficial for stroke patients (10, 13).

The patients who participated in the training program were also favorably inclined toward this kind of training. They found it pleasant to get up from the bed or the chair to stand up for a little while, and to see the nurses come up to them every hour in the beginning of the training. As soon as they managed the program by themselves, they found that the day went by faster, and that they were responsible and active in their own rehabilitation. The physiotherapist and the occupational therapist appreciated that the nursing staff cooperated with them and with the patient.

The most difficult part of the study was the performance of the orthostatic tolerance tests. Many patients found them unpleasant, and as a result a few refused to participate in the second and/or the third test.

This randomized experimental study has shown that early activation by means of a regular standing scheme can improve orthostatic tolerance and ADL performance in about 40–50% of all patients admitted to hospital with a diagnosis of an acute stroke, primarily cerebral infarction. Although the patients appreciated the activation, it has to be emphasized that it must not take place against the will of the patients and that the patients must not have any of the exclusion criteria cited above.

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