CARDIOVASCULAR MEDICINE

Long term adherence to dietary recommendations after inpatient rehabilitation: prospective follow up study of patients with coronary heart disease

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Objective: To evaluate the adherence to nutritional recommendations in inpatient rehabilitation and the long term maintenance of dietary changes among patients with coronary heart disease.

Design: Prospective cohort study.

Setting: Two rehabilitation clinics in Germany.

Participants: A cohort of 1206 patients undergoing inpatient rehabilitation after an acute manifestation of coronary heart disease.

Main outcome measures: Self reported dietary intake before, during, and one and three years after rehabilitation measured with a semiquantitative food frequency questionnaire and summarised to a nutritional index, which was used to categorise patients as having a poor, fair, or good diet.

Results: During rehabilitation the proportion of patients whose dietary intake was categorised as good increased strongly from 30% to 91%. One and three years after rehabilitation a still increased proportion of 49% and 42%, respectively, in the good category was observed. The strong increase in intake of low fat and wholemeal products that was achieved during rehabilitation was followed after rehabilitation discharge by a backslide to the intake observed before rehabilitation admission. The avoidance of unfavourable food items, such as French fries or eggs, was at least partly maintained during the follow up period.

Conclusion: During inpatient rehabilitation most patients do have to make major changes in their dietary intake to comply with recommendations. Although some proportion of patients continue to adhere to dietary recommendations in the long run, further research into strategies to improve maintenance of dietary changes is needed to enhance further the long term benefits from cardiac rehabilitation.

Poor diet and nutrition have been extensively investigated as primary risk factors for coronary heart disease (CHD).

Dietary strategies have been identified that are effective in preventing CHD, such as the substitution of non-hydrogenated unsaturated fats for saturated and *trans*-fats or the increased consumption of omega-3 fatty acids.¹ Furthermore, dietary patterns or nutrients are determining the occurrence of secondary cardiovascular disease events in patients with existing CHD.²⁻³ Therefore, nutritional counselling is a key factor in comprehensive rehabilitation programmes for patients with CHD.

The long term effectiveness of nutritional counselling within the inpatient cardiac rehabilitation programme has not been evaluated. In clinical practice, effectiveness is affected by the patient's adherence to the nutritional recommendations and the long term maintenance of dietary changes. Surveys of small patient groups suggest that patients with CHD are willing to make changes in their diet and that patients at least partly comply with dietary recommendations in the short term (3-6 months).⁴⁻⁷ However, data on long term compliance with dietary recommendations after discharge from inpatient cardiac rehabilitation are lacking.

In this study we assessed dietary intake during inpatient rehabilitation and evaluated the maintenance of dietary changes within the first three years after cardiac rehabilitation in a large cohort of patients with CHD.

METHODS

Study design and study population

We conducted a longitudinal study with long term follow up among patients undergoing inpatient rehabilitation after an

acute coronary event. The study design has been described in detail elsewhere.⁸⁻⁹ Briefly, all patients aged 30-70 years participating in a three week inpatient rehabilitation programme after an acute manifestation of CHD (acute coronary syndrome or coronary artery revascularisation procedure, *International classification of diseases*, 9th revision, codes 410-414) between January 1999 and May 2000 in one of two participating rehabilitation clinics in Germany were enrolled in the study. Only patients who were admitted within three months after the acute manifestation of CHD were included. All participants gave written informed consent. The study was approved by the ethics boards of the universities of Ulm and Heidelberg and of the medical associations of the states of Baden-Wuerttemberg and Hessen.

Dietary intervention during inpatient rehabilitation

In Germany all patients who were hospitalised due to an acute coronary syndrome or coronary artery revascularisation (that is, coronary artery bypass grafting, coronary angioplasty, and stent implantation) have the possibility to take part in an inpatient rehabilitation programme after discharge from the acute care hospital. The goals of this programme are to regain and maintain optimal physiological and psychological health and social integration. The comprehensive programme addresses physical therapy, relaxation techniques, psychological care, social and occupational counselling, and health education. About two thirds of eligible patients in Germany make use of this inpatient rehabilitation programme, which is covered by health insurance plans or pension funds.¹⁰

The dietary component comprises individual and group counselling, lectures, cookery courses, written information

Table 1 Rating of food frequency for each item (number of servings a week) for the calculation of the nutritional index

	Nutritional index points for weekly servings		
	2 points	1 point	0 points
Meat (about 150 g)	>1 to <5	5 to <6 or 0.5 to 1	≥6 or <0.5
Sausage, low fat (slices)	2 to 18	>18 to <25 or <2 to ≥0.5	≥25 or <0.5
Side dishes rich in starch, low fat	≥8	6 to <8	<6
French fries, baked potatoes	None	≤0.5	>0.5
Eggs (pieces)	None	≤1	>1
Milk, hot chocolate (0.2 l)	≤3	>3 to 7	>7
Margarine, low fat (10 g)	10 to 17	>17 to <25 or 7 to <10	≥25 or <7
Curd cheese, yogurt, buttermilk (150 g)	>5 to 9	3 to 5 or >9 to 13	<3 or >13
Cream	None	≤0.5	>0.5
Cheese, low fat (slices)	14 to 19	7 to <14 or >19 to <26	<7 or ≥26
Fresh fruits (pieces)	≥9	7 to <9	<7
Salad or vegetables, raw	≥12	7 to <12	<7
Vegetables, cooked	≥6	4 to <6	<4
Bread, proportion wholemeal	≥75%	50% to <75%	<50%
Breakfast cereals	5 to 8	3 to <5 or >8 to 14	<3 or >14
Chocolate (bars)	None	≤0.5	>0.5
Cake, cookies	≤1	>1 to <2	≥2
Salty snacks (100 g)	None	≤0.5	>0.5
Convenience food	None	≤0.5	>0.5
Drinks, low energy (l)	≥10.5	8.5 to <10.5	<8.5

material, and specific courses for patients with diabetes. The dietary education promotes a balanced diet characterised by a high intake of fruits, vegetables, wholemeal foods, and high quality fat and a low intake of animal fat, sugar, and salt.

Data collection

Information on dietary intake was obtained from participants at the beginning and at the end of rehabilitation and at one year and three years after rehabilitation discharge. Each time the same semiquantitative food frequency questionnaire (FFQ) consisting of 36 items was applied. Standard portion sizes were listed for items, and participants had to enter the number of those portions consumed on average every day, week, or month. While the FFQ at the beginning of rehabilitation and at the follow up examinations covered the respective previous 12 months, at the end of rehabilitation data on nutrition during rehabilitation were obtained. To avoid selection effects only patients with data on food intake in all four questionnaires were considered in the analysis (beginning of rehabilitation: $n = 1195$; end of rehabilitation: $n = 1172$; one year's follow up: $n = 1039$; three years' follow up: $n = 899$; overall complete data: $n = 880$).

Statistical analyses

After describing the study population with respect to various sociodemographic and medical characteristics, the median dietary intake of individual food items at each time point was determined.

Data on dietary intake were then summarised to a nutritional index, which table 1 shows.¹¹ This index was developed at study commencement and its performance was evaluated with data on dietary intake during rehabilitation collected from a subset of patients through the FFQ and a three day food record. Thus, the index was constructed and validated without knowledge of the changes in food intake during the study.

For each item recorded in the FFQ the desirable intake was specified by the diet served in the clinics, which was based on the recommendations made by nutritional associations. Overall the index favours a balanced diet with sound intake of meat and low fat foods, high intake of fruits, vegetables, and wholemeal bread, and avoidance of eggs, cream, sugar rich foods, salty snacks, French fries (chips), and convenience food.

Thus, the index reflects main aspects of dietary education during rehabilitation and still allows flexibility in food intake to suit individual tastes. Adherence to the recommendations for each food item was graded as good (2 points), fair (1 point), or poor (0 points), and the points gained from the individual items were then added up to an overall score. With 20 food items included the score could take on any value between 0 and 40. The tertiles of the nutritional index at the beginning of rehabilitation were used to establish cut off points for a summary rating of good, fair, or poor diet.

The distribution of eating behaviour was determined for each time point separately. The significance of the changes over time in relation to baseline eating behaviour was evaluated by using Bhappkar's test for marginal homogeneity.¹² In addition, the changing behaviour of patients within the three possible beginning conditions (poor, fair, and good) was determined.

The prevalence of obesity (body mass index $> 30 \text{ kg/m}^2$) and high total cholesterol ($> 5.2 \text{ mmol/l}$), high low density lipoprotein cholesterol ($\geq 3.4 \text{ mmol/l}$), low high density lipoprotein cholesterol ($< 1.0 \text{ mmol/l}$), and high triglyceride concentrations ($> 2.3 \text{ mmol/l}$) was compared for the categories of nutritional index at the one year and three year follow ups and significance was tested with Pearson's χ^2 . All data were analysed by using the statistical software package SAS, release 8.1 (SAS Institute, Cary, North Carolina, USA).

RESULTS

Overall, 1206 patients with newly diagnosed CHD were enrolled at baseline during the inpatient rehabilitation, of whom 880 provided data on food intake at all four measurement points. No major differences in baseline characteristics were observed between the total cohort and the subset of participants with complete longitudinal data on food intake, who were considered in the analysis (table 2). The majority of participants were 50–70 years old and male. Only 17% of patients reported a school education of more than 11 years and the majority of patients were married. Increased body weight was prevalent, as was lifetime smoking. More than half of the patients reported a history of hypertension and 15% a history of diabetes; 57% had had a myocardial infarction.

Table 2 Sociodemographic and medical characteristics of participants recruited into the study (n = 1206) and of participants with data on food intake at all four measurement points (n = 880)

Characteristics at baseline	Total cohort		Complete longitudinal information on food intake	
	Mean (SD)	No (%)	Mean (SD)	No (%)
Age (years)	58.7 (8.2)		59.2 (7.8)	
30–39		29 (2.4%)		15 (1.7%)
40–49		158 (13.1%)		106 (12.1%)
50–59		350 (29.0%)		246 (28.0%)
60–70		669 (55.5%)		513 (58.3%)
Women		190 (15.8%)		134 (15.2%)
School education >11 years		204 (17.2%)		146 (16.9%)
Family status: married		990 (82.1%)		757 (86.0%)
Body mass index (kg/m ²)	26.9 (3.3)		26.8 (3.2)	
≤25		336 (27.9%)		259 (29.5%)
>25–30		676 (56.1%)		493 (56.2%)
>30		189 (15.7%)		125 (14.3%)
Cigarette smoking				
Never smoker		373 (31.0%)		296 (33.8%)
Former smoker		764 (63.6%)		547 (62.4%)
Current smoker		65 (5.4%)		34 (3.9%)
History of hypertension		667 (55.3%)		496 (56.6%)
History of diabetes		212 (17.6%)		134 (15.4%)
History of MI		716 (59.4%)		502 (57.1%)

MI, myocardial infarction.

During rehabilitation the median intake of recommended food items such as low fat sausage, margarine, and cheese and wholemeal bread increased strongly compared with the year before rehabilitation while the intake of high fat and not recommended food items such as French fries, milk, eggs, white bread, and cake decreased (table 3). However, after discharge from rehabilitation a reverse trend was observed and the median intake of recommended food items dropped to levels close to those before rehabilitation for low fat

sausage, margarine, and cheese, wholemeal bread, water, and tea. Although the mean intake of unfavourable items increased in parallel, the median intake of these items remained in general still clearly below the median intake before rehabilitation.

In the 12 months preceding rehabilitation the participants reached a mean nutritional index of 17.8 (table 4). During rehabilitation the mean nutritional index increased to 26.0 but dropped to 20.4 in the first year after rehabilitation and

Table 3 Median number of weekly servings reported by patients with CHD before, during, and after rehabilitation

	Time relative to rehabilitation			
	Year before	During	First year after	Third year after
Meat (about 150 g)	4	5	3	3
Sausage, low fat (slices)	3	7	3	3
Side dishes rich in starch, low fat	6	6	6	6
Potatoes	3	3	3	3
Pasta	2	2	2	2
Rice and other grains	1	1	1	1
French fries, baked potatoes	0.5	0	0.2	0.2
Eggs (pieces)	1	0	0.5	0.7
Milk, hot chocolate (0.2 l)	1	0	0.5	0.5
Margarine, low fat (10 g)	0	14	7	5
Curd cheese, yogurt, buttermilk (150 g)	3	4	3	3
Cream	0	0	0	0
Cheese, low fat (slices)	2	7	3	3
Fresh fruits (pieces)	7	7	7	7
Salad or vegetables, raw	4	7	5	5
Vegetables, cooked	3	3	3	3
Bread, proportion wholemeal	40%	67%	50%	50%
Bread, wholemeal (slices)	7	14	7	7
Bread, white	10	7	7	7
Breakfast cereals	0	0	0.2	0
Chocolate (bars)	1	0	1	1
Cake, cookies	2	0.5	1	1
Salty snacks (100 g)	0.2	0	0	0
Convenience food	0.5	0	0.5	0.2
Drinks, low energy (l)	11.2	12.6	11.2	11.2
Pop, low energy (0.2 l)	0	0	0	0
Mineral water (0.2 l)	28	35	28	28
Coffee (1 cup)	14	14	14	14
Tea (1 cup)	7	14	5	7

Table 4 Mean value and distribution of nutritional index before, during, and after rehabilitation

	Time relative to rehabilitation			
	Year before	During	First year after	Third year after
Mean (SD) nutritional index (points)	17.8 (5.3)	26.0 (4.2)	20.4 (5.0)	19.5 (4.7)
Distribution (points)				
Poor (0–15)	318 (36.1%)	9 (1.0%)*	148 (16.8%)*	175 (19.9%)*
Fair (16–20)	301 (34.2%)	68 (7.7%)*	299 (34.0%)	333 (37.8%)
Good (21–40)	261 (29.7%)	803 (91.3%)	433 (49.2%)	372 (42.3%)

*Change related to baseline nutritional index category significant at $p < 0.0001$.

then remained relatively stable. The distribution of patients in the categories of the nutritional index changed accordingly from 30% in the good dietary intake category before rehabilitation to 91% in the same category during rehabilitation. After rehabilitation the proportion of patients in the good category dropped to 49% in the first and to 42% in the third year. The change in categories of nutritional index related to baseline eating was significant at $p < 0.0001$ at all follow up examinations.

Figure 1 shows the changing behaviour of the three possible beginning conditions during the follow up. Among patients with poor eating behaviour at baseline (left hand side) close to 100% improved their diet during rehabilitation. After discharge a subset of patients relapsed to the poor diet but majorities of 68% and 61% remained in the fair and good categories of nutritional status at the one year and three year follow ups, respectively. Similarly, among patients initially reporting a fair diet at baseline (middle) more than 90% enhanced their diet during rehabilitation. Some relapse, even into the poor category, was observed after rehabilitation discharge, but the group that improved their diet to good is larger than the group that moved to the poor diet at both the one year and three year follow up. In the group of patients who reported a good diet at baseline (right hand side), some patients moved to categories with a worse diet but even three years after rehabilitation discharge 69% of patients were still in the good category of the nutritional index.

The nutritional index at various measured points was positively correlated, with Spearman rank correlation coefficients of 0.22 (beginning and end of rehabilitation), 0.34 (end of rehabilitation and one year of follow up), and 0.62 (one year and three years of follow up), which indicates some stability of the rank order of dietary pattern between patients.

Patients in different categories of the nutritional index did not differ significantly with respect to prevalence of obesity, high total, high density lipoprotein, or low density lipoprotein cholesterol concentration, or high triglyceride concentration at the various measurement points.

DISCUSSION

In this study of a large group of patients undergoing inpatient cardiac rehabilitation we observed major improvements of dietary intake during rehabilitation compared with previous nutritional patterns. However, one and three years after rehabilitation these improvements were only partially maintained.

The nutritional index used in this study has been developed on the basis of recommendations made by nutritional associations, which were also the basis for the meals served in rehabilitation clinic. Thus, as long as patients do attend meals and do not consume extra food the high proportion of patients in the good dietary intake category during rehabilitation can be easily explained and essentially reflects adherence to the diet served in the clinic during

Figure 1 Distribution of categories of the nutritional index at baseline (BL), during rehabilitation (rehab), at one year of follow up (FU1), and at three years of follow up (FU3) among patients with poor (left), fair (middle), and good (right) eating behaviour at baseline.

rehabilitation. Furthermore, this finding is in line with results from other studies that showed that patients can make major dietary changes after myocardial infarction in the short term.^{6 7 13}

Maintaining dietary changes in daily life, however, is more difficult. As seen in this study, after discharge from hospital participants do partly relapse to earlier eating habits. However, compared with the diet before rehabilitation, patients' diets were improved even three years after rehabilitation discharge. Results from previous studies with small sample sizes suggest that the partial recurrence of unfavourable dietary habits has to be expected and that the degree of change and maintenance depends also on the intensity of nutritional education.^{7 13-16} In a small interventional study the intervention group maintained the improved dietary intake 12 weeks after rehabilitation.⁷ However, in that study the intervention group comprised a non-representative patient group with high motivation for lifestyle changes. In a Finnish study partial recurrence of poor dietary intake was already observed six months after rehabilitation.⁶

The cardiac rehabilitation programme in Germany includes a comprehensive dietary programme, which comprises different types of activities. However, most of the activities are provided on a voluntary basis and the tight schedule in inpatient rehabilitation may not allow participation in all cases. Thus, in our study, 88% of participants reported having visited lectures on healthy diet but only 30% received individual counselling and only 15% participated in cookery courses. A stronger emphasis on dietary intervention on an individual basis may be helpful in the discussion of the individual situation and how to overcome obstacles such as family eating habits, local availability of food, or time available for food preparation. Furthermore, a better integration of dietary interventions in the long term management of patients with CHD is needed.

Our data suggest that patients with CHD are more likely to maintain the avoidance of specific food items than the substitution of, for example, high fat with low fat food products. These results are partly in contrast to findings from studies conducted in other countries. In a Finnish group of coronary patients an increased intake of low fat milk and cheese was observed six months after dietary counselling.⁶ However, even before counselling the intake of low fat milk and cheese had been higher than that of high fat milk and cheese, particularly in the group that responded well to dietary counselling. In the women's health trial a high frequency of substitution of low fat products for high fat foods was observed 12 months after study completion.¹⁷ In Germany low fat products are less popular in general. A survey among adolescents showed that the consumption of low fat dairy products is increasing but they still make up only 25% of all dairy products consumed.¹⁸ In our cohort the intake of low fat products, such as cheese and sausage, was lower than the intake of high fat products before rehabilitation. The low popularity of low fat products in Germany in general may contribute to a decreased acceptance of low fat products by patients with CHD. This, however, does not necessarily appear problematic by itself, since the intake of high fat animal products such as cheese, sausage, and butter nevertheless remained low and thus a decrease in intake of saturated fats was achieved in the long run.

In the interpretation of our results, the following limitations should be considered. The FFQ applied in the study was not designed for a quantitative analysis of nutrient intake. In particular, the intake of specific nutrients such as omega-3 fatty acids that are associated with a decrease in cardiovascular diseases cannot be assessed.³ Furthermore, points are given for the consumption of fat reduced food items but not for avoidance of high fat items, which appears to be, as

discussed earlier, the predominant strategy in our population. Still, the nutritional index determined from the FFQ does allow an assessment of the nutritional intake overall and gives information on adherence to dietary recommendations, which was the primary interest in our study.

We were not able to retrieve complete data on dietary intake for all patients over the complete follow up period. However, the participants with complete longitudinal information on food intake were not different from the overall cohort with respect to major sociodemographic and medical characteristics and their mean nutritional index before rehabilitation. Our results are therefore likely to be representative for all initially recruited participants. Although inpatient rehabilitation is offered to all patients after acute coronary syndrome or coronary revascularisation in Germany, patients with more severe disease who may be too sick to participate in such programmes may nevertheless be underrepresented.

Since all dietary data are self reported, there may be some misclassification due to inaccurate reporting. The patients might have been particularly hesitant to report any divergence from the diet served during rehabilitation—that is, to admit eating food additional to the meals served. Dietary quality during rehabilitation may therefore have been somewhat overestimated but this alone is unlikely to explain the strong improvement during rehabilitation and the reverse trend afterwards.

Despite these limitations we conclude that patients with CHD can achieve major improvements in dietary intake in the short run. Although some proportion of patients continue to adhere to dietary recommendations in the long run, further research into strategies to improve maintenance of dietary changes, for example, by involvement of spouses or reinforced advice, is needed to enhance further the long term benefits from cardiac rehabilitation.

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IMAGES IN CARDIOLOGY

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Mid aortic syndrome: a rare cause of reversible cardiomyopathy

A 7 month old girl (body weight 7 kg, length 73 cm) was presented with tachypnoea, hepatomegaly, vomiting, decreased peripheral perfusion, systolic heart murmur, and sinus tachycardia of up to 205 beats/min. She had a short history of decreasing activity for about four weeks. Radiography showed an enlarged heart, and echocardiography showed the left ventricular function was depressed with severe mitral regurgitation and mild tricuspid regurgitation. M mode showed left ventricular end diastolic diameter (LVEDD) 28 mm, fractional shortening (FS) 19%, and ejection fraction (EF) 49%. The aortic valve was without pathological findings and an aortic coarctation in the isthmus was excluded. Coronary arteries were normal; anomalous left coronary artery from pulmonary artery (ALCAPA) syndrome was excluded. Femoral pulse deficit and a difference of 50 mm Hg in systolic blood pressure between the arms and the legs pointed to the diagnosis, and magnetic resonance imaging verified stenosis of the distal thoracic aorta up to the diaphragm. There were no collaterals. Percutaneous

transluminal angioplasty with inflation pressure up to 8 atm was not successful (panel A). Subsequently surgery was performed without cardiopulmonary bypass through left lateral thoracotomy. A 10 mm diameter Gore-Tex prosthesis was implanted with end-to-side anastomosis. Panel B shows that the length of the bypass is oversized to allow for patient growth. Cardiac function improved within three days and mitral regurgitation vanished completely.

Mid aortic syndrome is a rare variety of aortic coarctation, located in the distal thoracic or the abdominal aorta, often involving the renal and intestinal vessels and presenting predominantly as untreatable arterial hypertension. In the later course it ends in congestive heart failure, mimicking dilatative cardiomyopathy.

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Angiography: the stenosis is 2 cm long with a minimum diameter of 3 mm; the diameter of the aorta proximal and distal to the stenosis is 8 mm.

A surgical view in the left hemithorax; a 10 mm diameter Gore-Tex prosthesis oversized in length was implanted to allow for anatomical growth.