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Individually adjusted meals for older people with protein-energy malnutrition: a single-case study

LENNART CHRISTENSSON MScN, RN

Doctoral candidate, Department of Medicine and Care, Division of Nursing Science, Faculty of Health Sciences, Linköping University, 581 85 Linköping and Department of Nursing Science, University College of Health Sciences, Box 1038, 551 11 Jönköping, Sweden

ANNA-CHRISTINA EK PhD, RN

Professor, Department of Medicine and Care, Division of Nursing Science, Faculty of Health Sciences, Linköping University, 581 85 Linköping, Sweden

MITRA UNOSSON DMSc, RN

Senior Lecturer, Department of Medicine and Care, Division of Nursing Science, Faculty of Health Sciences, Linköping University, 581 85 Linköping, Sweden

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Summary

• The objective of this study was to investigate the effect of a 3-month intervention programme consisting of meals based on individual nutritional requirements in residents assessed as protein-energy malnourished on admission to a municipal care Institution.

• Using a single-case design, 11 malnourished residents were given individual care aimed at fulfilling their personal requirements for energy intake during a period of 12 weeks. The residents were selected from a sample of 261 newly admitted older adults of whom 87 were assessed to be malnourished on admission. Nutritional status, including anthropometric and biochemical variables and functional capacities were assessed before, during, and after the intervention. Energy intake was recorded every day. Body weight, and serum concentration of albumin and transthyretin were measured every other week.

• During a 3-month period, the mean value of energy intake reached the calculated energy requirement in 10 residents. Eight residents increased in weight, triceps skin-fold thickness, and transthyretin concentration. Nine residents increased in arm muscle circumference, and 10 showed increased serum albumin concentration and functional capacity.

• We conclude that nursing care based on individual nutritional requirements, resources, and desires improves nutritional status and functional capacity in a group of malnourished residents.

Correspondence to: L. Christensson, Department of Nursing Science, University College of Health Sciences, Box 1038, 551 11 Jönköping, Sweden (e-mail: lennart.christensson@educ.ltjkpg.se).

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Introduction

Older people in long-stay hospital care or in municipal care are the groups most at risk of malnutrition (Larsson *et al.*, 1990; Kerstetter *et al.*, 1992; Cederholm & Hellström, 1992; Christensson *et al.*, 1999). Without special nutritional interventions, food intake in these people is often inadequate and below recommended energy expenditure (Unosson *et al.*, 1994, 1995; Elmståhl *et al.*, 1997). The nutritional deficit has a direct effect on general physical condition (Blaum *et al.*, 1995), the development and healing of pressure sores (Ek *et al.*, 1991), mental condition (Morley & Kraenzle, 1994; Blaum *et al.*, 1995), and on the mortality rate (Larsson *et al.*, 1990). The causes of malnutrition in older people are complex, involving physical, physiological, psychosocial, medical and economic factors (Rudman & Feller, 1989; Blaum *et al.*, 1995). Reduced mobility, the need for help during meals (Unosson *et al.*, 1991), and eating problems (Jacobsson & Axelsson, 1997) are factors associated with malnutrition. A meal environment which is similar to older people's previous active period of life increases energy intake (Elmståhl *et al.*, 1987).

Studies are often designed to find out the effect of dietary supplements in addition to regular meals (Larsson *et al.*, 1990; Tkatch *et al.*, 1992; Eneroth *et al.*, 1997). Supplementary nutrition improves the nutritional status of older people in hospital and geriatric care and results in significantly fewer complications and deaths as well as reduced hospital stays (Larsson *et al.*, 1990; Tkatch *et al.*, 1992). In a randomized study, Larsson *et al.* (1990) showed that a dietary supplement added routinely to standard hospital diets improved nutritional state. The supplement gave the greatest preservation of nutritional status and reduction in mortality rate in those who were not malnourished; a similar effect was not seen in the malnourished. In another randomized study, Fiatarone *et al.* (2000) showed that nutritional supplementation given to institutionalized older people at nutritional risk did not significantly increase total energy intake and that both nutritional supplement and placebo drink showed a negative impact on habitual food intake. Kerstetter *et al.* (1992) suggested that malnourished older people in hospital find it difficult to increase their food intake enough to improve their nutritional status. In view of the complexity of the causes of malnutrition and the fact that energy expenditure differs with gender, age, body weight, diseases and extent of physical activity (WHO, 1985), we postulated that an individually adjusted nutritional programme may be more successful in malnourished older people than the supplements offered routinely. We have not found any studies in which the nutritional intervention was based upon identified individual requirements, resources, and desires. Neither have any of the studies been based on the cause of the older people's reduced food intake.

Individuality is described in nursing publications as an important aspect of individual care plans (Hallberg & Norberg, 1993; Ehrenberg *et al.*, 1996) and as a goal of treatment (Happ *et al.*, 1996). Individualized care is linked to quality of life (Burgener *et al.*, 1993; Happ *et al.*, 1996). Happ *et al.* (1996) define individualized care for frail older people as 'an interdisciplinary approach which acknowledges elders as unique persons and is practised through consistent caring relationships'. In their practical description of individualized care the first step is 'knowing the person' in order to understand the older people's responses and behavioural symptoms. Sidenvall & Ek (1993) identified defective nursing assessment strategies, because older people in medical care reported experiences of deteriorated eating competence to a higher degree than the nursing staff did. They also found that the older people avoided expressing their needs and that some nurses thought they were prying if they asked questions about table manners (Sidenvall *et al.*, 1994).

If the underlying cause of malnutrition is identified and dealt with, ordinary food will most probably fulfil the residents' nutritional needs. Providing a treatment that is individualized in order to meet the older people's needs, and not merely presenting a standard technique, is an essential feature of the National Board of Health & Welfare (1998).

Since 1992, the municipalities in Sweden have been responsible for providing health care and medical services for older adults. This obligation is carried out in special types of housing, with a registered nurse in charge. According to individual requirements the service is offered in different levels of housing. In the service buildings the residents have merely mild dysfunctions and no high intensive need for nursing intervention. Those living in retirement homes need support, including help with dressing, going to the toilet, and assistance with eating. In nursing homes the residents need extensive nursing care and medical care as they may have diseases such as cancer, stroke sequelae or severe dementia (Hedin, 1993). In these homes, nurses are responsible for the nutrition of all residents and thus, the problems of those residents who have difficulties in meeting their own nutritional needs definitely fall within the domain of nursing (Swedish National Food Administration, 1991). This is in spite of the nurses not being responsible for food preparation and having only a shared responsibility for its delivery. When the residents need medical attention it is supplied by a general practitioner, employed either by the county council or by a private company. In Sweden very few municipalities employ dieticians.

We undertook this study of protein-energy malnourished residents in order to investigate the effect of a 3-month care plan consisting of measures to support their eating process and meals based on individual energy requirements. The outcome was measured with regard to nutritional status and functional capacity.

Methods

STUDY DESIGN

The study was carried out as a single-case A-B-C design. The method focuses on the performance of the same person over time (Kazdin, 1982). This single-case study was performed on 11 residents newly admitted to eight different care units. In each single-case a 2–3-week baseline (phase A) was followed by 12 weeks of intervention (phase B) and was completed within a 6-week follow-up period (phase C). The aim of the intervention was to fulfil the individual nutritional requirement, calculated as energy, by designing a nutritional care plan based on the resident's problems, desires, and resources. Different variables were assessed continuously during the whole study period (Fig. 1).

PARTICIPANTS

From October 1996 to October 1997, nutritional status was assessed in 261 residents who were newly admitted to a community residential home in the south of Sweden. Among these, 87 were assessed as protein-energy malnourished (Christensson *et al*., 1999). Protein-energy malnourishment constituted the main criterion for participating in the study (Table 1). The other criteria were planned to stay in a nursing home or in a retirement home for at least 4 months, and informed consent from the resident or next of kin. Residents with malignant disease, severe diseases of the liver or the kidney, and those who were in a terminal state were excluded. Fourteen residents who fulfilled the criteria were

Table 1 Criteria for protein-energy malnutrition

	Men	Women
Anthropometry		
Weight index percentage	<80	<80
TSF mm	≤6	≤12
AMC		
≤ 79 years cm	≤23	≤19
> 79 years cm	≤21	≤18
Serum proteins		
Transthyretin g/l	<0.23	<0.23
Albumin g/l	<36	<36

TSF = Triceps skin-fold thickness; AMC = Arm muscle circumference.
A resident was considered protein-energy malnourished if two or more of the nutritional variables were subnormal, including one anthropometric and one biochemical measurement (Symreng, 1982; Unosson *et al.*, 1995).

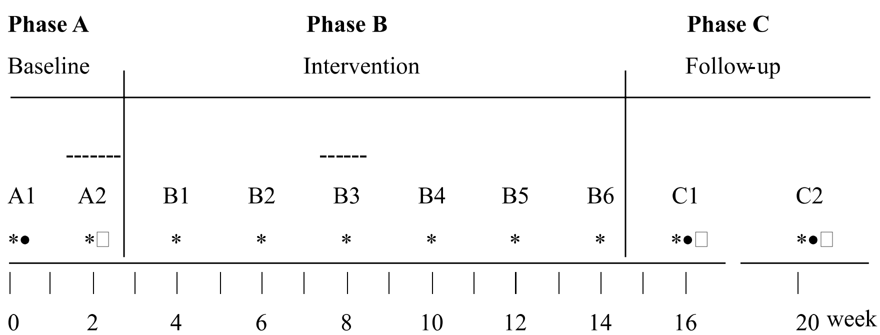

Figure 1 Flow chart of the study. *A1–C2* symbolise measurement occasions, *body weight, serum albumin and transthyretin. •Triceps skinfold thickness and arm muscle circumference. □ Functional capacity. ---- The total nutritional intake measured using the pre-coded food record book. Every day during the intervention, energy intake was registered using the simplified food record.

Table 2 Description of residents on admission

Case	Age	Sex	Weight loss*	Diseases recorded	Obstructions to the eating process	Focus during phase B
A	77	F	12%	Alzheimer's disease. Failed treatment of hip fracture 3 months earlier.	Does not understand how to use cutlery. Removes food from the mouth during feeding. Too weak to manage to sit in a chair. Needs help with ADL†. Does not respond to speech.	Adjusting the feeding technique e.g. placing the food in the back of the mouth, eating aids, e.g. a long narrow spoon, minced food, a wheelchair with a neck-aid. Supporting independent eating.
B	78	F	Non	Alzheimer's disease. NIDDM‡. Suspect thrombophlebites in Left leg.	Unsettled during the meal. Sometimes aggressive and refuses medication and food.	Eliminating disturbing phenomena. Constant access to supporting staff and creating a calm eating milieu.
C	86	M	11%	Senile dementia. Unspecified anaemia. Melaena at the end of phase B.	Swallowing disorder. Inability to use cutlery. Needs help with all ADL†. Unable to talk.	Minced food, assisted feeding with enough time between each bite, jellied fluid. Supporting independent eating.
D	77	F	Dm	Rheumatoid arthritis. Arteriosclerosis cerebri.	Reduced ability to use cutlery and to grasp the tumbler. Reduced appetite. Sometimes forgetful and confused.	Adjusted tools, meals composed after her taste, e.g. egg every breakfast, establishing routines, e.g. having meals together with the same ladies and giving support at start of meals.
E	93	F	10%	Unspecified diarrhoea. Gastroesophageal reflux. Pressure sore left malleolus, 1 × 1 cm. Cerebral ischaemia.	Weak, unable to walk, needs some help during the meals, e.g. to cut meat. Afraid of getting diarrhoea from the food. Running faeces, 2–5/day disturbing the meals. The sore gives her pain.	Finding a diet and a schedule which minimized the diarrhoea. Encourage Mrs E and her daughter to have an active role in the program. Giving support at start of meals.
F	86	F	10%	Depression. Heart failure. Cerebral infarct.	Feeble, tired, is anxious and shy. Bad appetite. Not accepted her new life as a resident in municipal care.	Encouraged to see the possibilities with the new housing, of eating in the dining room together with people she liked, to participate in social activities, adjust the flat according to her desire and encourage her daughter or granddaughter to visit every other day.
G	80	F	10%	Senile dementia. Repeated urinary infection.	Chewing and swallowing disorder. Anxious. Unable to talk. Needs help in all ADL†.	Creating a calm eating milieu, minced food and jellied fluid, assisted feeding with enough time between each bite and reducing the supporting staff to three.
H	84	F	Dm	Senile dementia. Heart failure.	Now and then aggressive, gets delusions and refuses to eat.	Eliminating disturbing activities, e.g. lowering the radio, to facilitate concentration, e.g. talk about the food and support at the start of the meal.
I	77	M	Dm	Arteriosclerosis. Right femur amputated 5 years ago and left femur 3 months ago. Pressure sore in sacrum, 6 × 6 cm. Secondary healing of surgery sore, 2 × 9 cm.	Pain. Independent eating with some difficulty. Bad appetite. Bed and electric wheelchair ridden. Needed help in some ADL-activities.	Improving his appetite by, e.g. serving meals he was longing for and slowly reducing appetite-decreasing drugs.

J	89	M	19%	Cardiosclerosis. Heart failure. Arteriosclerosis. Amputation of right lower leg 1 month ago.	Bad appetite. Pain. Bed and wheelchair-ridden.	Composing the meals according to his taste, reducing appetite-decreasing drugs and giving encouragement, e.g. to participate in physical training activities.
K	94	F	13%	Suspected transischaemic infarct 6 months ago.	Bad appetite. Decreased sight. Independent eating with some difficulties. Wheelchair-ridden.	Minced food, cutlery equipped with a thick handle, small portions with supplement between the meals and giving support during the meals.

* Weight loss in percent during the past 6 months.
† Activity of daily living including transferring, bathing, dressing, toilet visits feeding and continence.
‡ Non-Insulin-Dependent Diabetes Mellitus; Dm, data missing.

included in the study. One woman and one man were transferred to hospital and died later during rehabilitation. One woman was excluded because of the repeated need for hospital care. Eight women and three men, mean age 84 years (SD ± 6.3), completed the study (Table 2). Demographic data, current medical problems, drugs, and evidence of agitation or depression were collected from the resident's medical and nursing records. The resident, or their next of kin, gave informed consent after receiving oral and written information. The study was approved by the Research Ethics Committee, Faculty of Health Sciences, Linköping University, Sweden.

ENERGY REQUIREMENT AND ENERGY INTAKE

The basal metabolic rate was predicted using the equation given by the Nordic nutrition recommendations (1996). The equation is based on values from WHO/FAO/UNO (World Health Organisation, 1985), adjusted to the Nordic nutrition recommendations' interval of age and gender. Besides body weight, energy requirements were calculated assuming a physical activity level of 1.2 times basal metabolic rate, in residents who were bedridden or transported by wheelchair, and 1.4 in those who were able to walk. To serve meals containing the resident's estimated requirements of energy, a 'dietary plan' was developed based upon a computer program (AIVO, Stockholm, Sweden). The meals in the dietary plan were presented at three base levels: 5500-, 7200- and 9000-kJ. To facilitate serving at the right level, the meals were described in domestic terms such as 4 cm sausage, 0.75 decilitre cheese sauce, and two small potatoes. The base level was established by the resident's calculated energy requirement. No upper energy intake limit was set. If necessary, the staff were instructed to add supplements such as a sandwich or a portion of soup to reach the calculated requirement/day. To evaluate the residents' daily energy intake during phase B, a simplified food record based on the dietary plan was developed and used by the staff. A 7-day pre-coded food record book from the Swedish National Food Administration (Becker *et al.*, 1998) was used to record the residents' food intake during the second week of phase A and to validate the simplified food record. The validation was carried out in the seventh week, during phase B. The correlation coefficient between energy intake measured by the simplified food record and the pre-coded food record book was $r = 0.89$ ($P < 0.001$). Fluid intake was also recorded. Special requests, snacks and other in-between meals were recorded, in free text, each day.

NUTRITIONAL STATUS AND FUNCTIONAL CAPACITY

Height was measured in a supine position on a flat bed to the nearest 0.1 cm. Body weight was measured on a mechanical balance chair to the nearest 0.1 kg. The resident's weight in relation to length was used as one variable in the determination of malnutrition. Because disagreement about the lower Body Mass Index (weight/[height in m]^2) level for older people exists (Beck & Ovesen, 1998) and because of our experience from previous studies using weight index in a Swedish reference population of older adults (Bengtsson *et al.*, 1981; Symreng, 1982), weight index was considered to be the most accurate alternative. Weight index in per cent was calculated based on gender and age and from actual weight on admission divided by the reference weight × 100. The reference weight for older women was $0.65 \times$ height in cm – 40.4 kg, and for older men $0.80 \times$ height in cm – 62 kg (Bengtsson *et al.*, 1981; Warnold & Lundholm, 1984). The correlation between body mass index and weight index had a coefficient of $r = 0.97$. Triceps skin-fold thickness (TSF) was taken to be the average of three measurements obtained at the mid-arm point over the triceps muscle on the non-dominant arm using the Harpenden skin-fold calliper. On the same arm and site, mid-arm circumference (MAC) was measured with a flexible non-stretch tape. Arm muscle circumference (AMC) was calculated as follows: $\text{AMC} = \text{MAC} — 0.1\ (\pi \times \text{TSF})$ (Symreng, 1982). Serum albumin and transthyretin were measured using Rate Nephelometry (Beckman Array). For reference values of the biochemical measurements, local values were used (Table 1).

The residents' functional capacity was assessed before and after phase B using the Activity Index (Hamrin & Wohlin, 1982). The Activity Index contains 16 items with a maximum score of 92, subdivided into: mental capacity with four items (maximum score 32), motor activity with six items (maximum score 24) and activities of daily life with six items (maximum score 36). Lindmark & Hamrin (1988) have validated the Activity Index.

BASELINE (PHASE A)

The staff were instructed how to use the pre-coded food record book and, during the second week, they recorded the residents' food intake. Otherwise, ordinary care was given.

INTERVENTION (PHASE B)

One of the researchers identified nutritional problems by interviewing the resident, their relatives and in some cases also the staff. Meals were observed, and nursing and medical records were studied. A checklist covering social-psychological, physical, and economic barriers to adequate food intake was used (Kerstetter *et al.*, 1992). During the interview, data were collected concerning habits and desires, problems and how the residents managed their meals before admission. The observations were focused on phenomena interfering with the resident's food intake, such as eating problems and disturbing events in the dining environment. The records gave information about diseases and medical treatment that might influence food intake. In some cases an occupational therapist, a physiotherapist, or the resident's general practitioner were consulted.

After the problems had been analysed a care plan was set up in co-operation with the nurse in charge. The staff were informed about the care plan and that the aim was for the nutritional activity to reach the resident's calculated energy requirement. Staff members were instructed about the dietary plan and how to use the simplified food record. One of the researchers met the staff one to three times during the intervention period and discussed tasks and problems. The staff recorded successful and unsuccessful events during the meals, including the technique they used for assisted feeding, and complications such as nausea and diarrhoea. In some cases, the resident's relatives participated. If the energy requirement was not met a new examination was undertaken and the care plan was adjusted.

FOLLOW-UP (PHASE C)

During phase C, the nutritional programme was integrated as a part of the ordinary care programme, but the resident's food and fluid intake were not recorded and no staff meetings were held.

STATISTICS

As a result of our assumption that the dependent variables did not have a normal distribution, non-parametric tests were used. In order to describe the dependent variables during phases A, B and C, medians and ranges were used. Consequently, the effects of separate extreme values were minimized. By measuring body weight and serum proteins every second week, the progression could be followed and if values declined the intervention could be changed. In testing the hypothesis, Wilcoxon's signed-rank test was used when data were paired, and the Wilcoxon's rank-sum test when two independent groups were being compared. Differences were considered significant at $P < 0.05$. The correlation between the simplified food record and the pre-coded food record book was tested using Pearson's coefficient of variation.

Results

Factors affecting nutrition were dementia in three residents (A, B, H), dementia and dysphagia in two (C, G), operations and appetite-reducing drugs in two (I, J), disability in cognition and physical functions in two (D, K), fear of incontinence in one (E) and state of mind and motivation in one (F). Despite nutritional problems, oral nutrition was assessed to be adequate in these residents.

PHASE A

On admission, the mean weight index was 76 ± 13%, triceps skin-fold thickness was below the 10th percentile of the reference value for the Swedish population, as was arm muscle circumference in all three men and in Mrs K. Serum albumin concentration was below the reference value (<36 g/l) in all residents. Serum transthyretin concentrations were below reference values (0.23 g/l) in seven residents. According to the criterion used to determine protein-energy malnourishment (Table 1), one resident (resident D) fulfilled two criteria, three residents (residents B, G and H) fulfilled three criteria and the remaining seven residents fulfilled four or all five criteria.

Table 3 Differences between calculated energy requirement per day and mean energy intake per day (kJ) during the second week of baseline (phase A) and the seventh week of intervention (phase B) in 11 malnourished residents

Resident	Phase A	Phase B
A	−1850	1000
B	3050	1650
C	950	2750
D	900	300
E	−300	−450
F	50	±0
G	100	700
H	2600	3500
I	650	1350
J	1400	1000
K	−1150	±0

The pre-coded food record book was used.

In three residents, the mean energy intake did not meet calculated requirements during phase A (Table 3). During this phase, six residents lost or maintained their weight. Serum albumin and transthyretin concentrations decreased or remained unchanged in nine and eight residents, respectively.

PHASE B

During phase B, the weight of eight residents increased, triceps skin-fold thickness increased in eight and arm

Table 4 Body weight, arm muscle circumference (AMC) and triceps skin-fold thickness (TSF) during baseline (phase A), intervention (phase B) and follow-up (phase C) in 11 residents assessed as protein-energy malnourished on admission to municipal care

	Body weight in kg				TSF in mm			AMC in cm		
Resident	Phase A*	B†	Range during B	C‡	A§	B¶	C**	A§	B¶	C**
A	46.6	44.1	43.5–44.9	45.2	7.5	7.0	7.0	19.5	19.8	19.3
B	52.0	53.5	53.0–56.0	55.9	9.5	11.0	12.0	19.5	20.0	20.5
C	53.3	53.9	52.5–54.4	53.5	4.5	5.0	5.2	19.6	19.4	18.6
D	49.8	47.9	46.7–49.0	47.3	10.2	8.2	8.1	19.2	18.2	18.5
E	48.8	50.3	49.5–50.5	50.0	7.5	6.8	7.0	20.1	22.5	22.5
F	46.6	48.3	46.0–52.0	51.5	10.0	13.8	11.8	19.9	21.1	20.8
G	50.9	53.4	52.0–55.2	53.2	7.2	7.9	8.2	19.4	21.2	19.1
H	63.1	65.5	62.8–68.5	67.1	9.0	11.0	11.2	23.7	24.5	25.9
I	35.9	35.0	34.5–38.1	39.8	4.3	5.0	4.6	21.4	22.1	23.4
J	50.8	52.7	50.1–56.5	63.1	5.8	10.0	10.6	17.9	20.7	21.5
K	30.7	32.7	31.6–33.2	32.9	5.6	5.8	4.8	5.6	16.6	16.0

* The median from two assessments (A1 + A2).
† The median from six assessments (B1 − B6).
‡ The median from two assessments (C1 + C2).
§ Measured on admission (A1).
¶ After phase B ceased (C1).
** At end of phase C (C2).

Table 5 Serum albumin and transthyretin during baseline (phase A), intervention (phase B) and follow-up (phase C) in 11 residents malnourished on admission to municipal care

	Serum albumin g/l				Transthyretin g/l			
Resident	Phase A*	B†	Range during B	C‡	Phase A*	B†	Range during B	C‡
A	31	33.5	28–37	37.5	0.225	0.200	0.18–0.30	0.230
B	35	38	37–39	39.5	0.220	0.240	0.20–0.29	0.305
C	28.5	26.5	24–29	26.5	0.105	0.130	0.10–0.15	0.130
D	34	35	32–36	35.5	0.315	0.305	0.27–0.32	0.305
E	34.5	37	32–38	38	0.265	0.235	0.21–0.28	0.255
F	29.5	32	30–35	31.5	0.185	0.225	0.16–0.30	0.205
G	28.5	31	26–34	30.5	0.185	0.210	0.20–0.26	0.270
H	32	35.5	34–40	37	0.235	0.275	0.26–0.29	0.310
I	26	31.5	27–33	33	0.205	0.240	0.22–0.25	0.250
J	32.5	38	36–42	40.5	0.215	0.305	0.28–0.31	0.300
K	31.5	33	28–38	32	0.215	0.220	0.17–0.24	0.220

*The median from two assessments (A1 + A2).
† The median from six assessments (B1 − B6).
‡ The median from two assessments (C1 + C2).

Table 6 Functional capacity before (A2) and after intervention (C1) in 11 residents assessed as being malnourished on admission to municipal care

	Mental capacity score (max. score 32)		Motor activity score (max. score 24)		ADL function score (max. score 36)		Functional capacity score (max. score 92)	
	A2	C1	A2	C1	A2	C1	A2	C1
A	14	14	11	16	10	11	35	41
B	20	21	24	24	23	27	67	72
C	13	11	14	16	11	12	38	39
D	29	27	20	24	32	36	81	87
E	28	32	19	21	21	24	68	77
F	30	32	24	24	36	36	90	92
G	11	11	12	12	10	11	33	34
H	24	24	22	22	20	20	66	66
I	30	32	16	16	21	30	67	78
J	28	32	21	24	27	36	76	92
K	22	28	16	18	20	20	58	66

muscle circumference in nine residents (Table 4). Serum albumin concentration increased in 10 residents and transthyretin in eight (Table 5). At the end of phase B (B6), serum albumin concentration was above the reference value in four residents and transthyretin in eight. Functional capacity score increased in 10 residents during phase B: six improved in mental capacity score, five in motor activity score, and nine in activities of daily living score (Table 6). In five residents with dementia, the median value for change in the total activity index score during phase B was + 1, compared to + 8.5 ($P < 0.05$) in the six who did not have dementia. The median value for change in mental capacity score was 0 in those with dementia, compared to + 3 ($P < 0.05$) in the rest. During the seventh phase B week, all residents except resident E met their calculated energy requirement. According to the pre-coded food record book, no significant difference in energy intake was seen between the second week of phase A and the seventh week of phase B (Table 3).

At the end of phase B, residents A, B, D, E, F and J no longer fulfilled the criteria for protein-energy malnourished. Resident H was still protein-energy malnourished after phase B but was not 6 weeks later. Residents D and F returned from non-protein-energy malnourished at the end of phase B to protein-energy malnourished 6 weeks later. Residents C, G, and K remained protein-energy malnourished during the whole study period.

PHASE C

Comparing median values of phase B with median values of phase C, the body weight of seven residents increased or remained unchanged, with the corresponding figure for serum albumin concentration being eight residents, and for transthyretin nine residents (Tables 4 and 5). The activity index score continued to increase in three residents, was decreased in one, while the remainder retained phase B scores.

After the intervention, the residents, taken as a group, significantly increased in body weight, arm muscle circumference, serum concentrations of albumin and transthyretin, motor activity, activities of daily living, and total

Table 7 Anthropometry, serum proteins and functional capacity on admission (A1), at end of intervention (B6) and at end of follow-up (C2) in 11 malnourished residents

	Occasion A1 Md (range)	Occasion B6 Md (range)	Occasion C2 Md (range)
Anthropometry			
Body weight kg	49.8 (31.0–62.8)	52.0 (32.6–67.2)*	50.5 (33.0–67.1)
TSF mm	7.5 (4.3–10.2)	7.9 (5.0–13.8)	8.1 (4.8–12.0)
AMC cm	19.5 (15.6–23.7)	20.7 (16.6–24.5)*	20.5 (16.0–25.9)
Serum proteins			
Serum albumin g/l	33 (20–35)	35 (24–42)*	35 (29–42)
Transthyretin g/l	0.22 (0.10–0.20)	0.24 (0.11–0.30)*	0.26 (0.14–0.35)
Functional capacity			
Mental capacity score	24 (11–30)	27 (11–32)	27 (11–32)
Motor activity score	19 (11–24)	21 (12–24)*	21 (12–24)
ADL function score	21 (10–36)	24 (11–36)*	24 (9–36)
Total activity index score	67 (33–90)	72 (34–92)†	77 (34–92)

Wilcoxon signed-rank test, $*P < 0.05$, $\dagger P < 0.01$.

activity scores. No significant difference was seen between values at the end of intervention and those at the end of the follow-up (Table 7). Six months after the end of the study all 11 residents were alive and in municipal care.

Discussion

We studied the effect of a nutritional intervention programme on nutritional status and functional capacity in 11 residents assessed as protein-energy malnourished on admission to municipal care. The characteristics of the residents were that they had complicated diseases and disabilities, their anthropometric measurements and serum protein concentrations were reduced, and they were all in need of extensive and varied kinds of care (Tables 2, 4 and 5). During the intervention period, all residents except E, met calculated energy requirements. We showed increased nutritional status in all but one resident (resident D), and improved functional capacity in all but one (resident H). Most of the improvements were attained during the intervention phase (phase B).

Among the five residents with dementia (residents A, B, C, G, and H), the eating process was disrupted by various problems. Energy intake, however, met calculated energy requirements in all of them during the intervention phase. This affected anthropometric measurements and serum protein concentrations in a similar way to the non-dementia residents, but the benefit of the nutritional intervention, measured by functional capacity, was significantly lower. This is in accordance with our earlier studies (Unosson *et al.*, 1992, 1995). During the nutritional intervention, mental capacity improved in the residents, but not in those with confirmed dementia. Aggressive oral re-feeding programmes using high-caloric foods have been shown to improve mental status for multiply impaired elderly people (Winograd & Brown, 1990).

During the intervention period, medical problems arose, including melaena in resident C, an inflammatory process in resident D and a urinary infection in resident G. It is very likely that these factors affected the nutritional status. Serum protein concentrations, for example, are influenced by factors such as infections and chronic active diseases (Fleck & Path, 1988). Even though no single nutritional variable in itself could define the resident as protein-energy malnourished or not, it is important to continuously assess the value because it can change the nutritional intervention. For example, in two residents, weight gain during the later part of the intervention called for a new energy calculation which indicated that the meals should be served at one of the higher energy levels. To minimize influence by other factors apart from dietary intake, reduced nutritional status was based upon fulfilling a combination of at least two criteria (Table 1). The observation that 10 of the 11 participants in this study fulfilled three or more nutritional criteria on admission confirms their poor nutritional condition.

Even though residents I and J had reduced nutritional status on admission, their problems with pain, reduced mobility, and appetite were identifiable. They improved most during the nutritional programme with regard to functional capacity (Table 6). In contrast, the psychosocial problems in resident F were less visible. In this case, the process of food-recording during intervention may, in itself, have provided the attention the resident needed during meals. From the simplified food record, the staff received information about the extent to which the goal had been achieved after every meal. When food intake recording ceased during follow-up, less attention was paid to the resident and the nutritional values dropped. This demonstrates the need for older people to receive proper assessment of their nutritional requirements as well as the need for nurses to value 'helping residents to eat' as an important nursing activity.

During intervention, residents A and I continued to lose weight despite energy intake meeting calculated requirements. It is likely that energy requirements were affected by an active disease process and this factor was not taken into account in the calculation. This may have resulted in an underestimation in these two residents. After 6 weeks, however, their weight started to increase. The achievement of increased body weight in older people who receive nutritional supplements to correct weight is a time consuming process (Larsson *et al.*, 1990; Johnson *et al.*, 1993).

On admission, two residents (residents E and I) had skin sores, which healed during the intervention. Adequate nutrition is an important factor in wound healing (Ek *et al.*, 1991; Eneroth *et al.*, 1997).

The nutritional intervention may have contributed to the survival of all residents 6 months after admission. We have previously reported that the mortality in protein-energy malnourished residents during an ordinary nutritional programme was 38%, measured 6 months after admission to municipal care (Christensson *et al.*, 1999).

One of the greatest practical limitations of group comparisons in clinical research is the relatively small number of sufficiently homogeneous patients. In within-subject analysis, on the other hand, factors such as age, gender, diagnosis, education level, diseases, and all possible significant life experiences are kept constant up to the beginning of the study (Ottenbacher, 1990). Single-case experimental design is ideal for evaluating nursing care because it focuses on individual cases, making it possible to give individualized nursing care while simultaneously studying the outcomes of specific patients (Behi & Nolan, 1997). The A–B–A–B design, which is the most basic experimental design in single-case research (Kazdin, 1982), was not applicable in this study. Ethical considerations demanded that the plan of action could not be removed during follow-up, neither could the effects of education during intervention be withdrawn. It would be unethical to randomize malnourished residents to a control group where they would be deprived of nutritional interventions. When residents are assessed as malnourished, the nutritional measures must be taken. For ethical reasons, single-case design is most suited for research in these circumstances (Behi & Nolan, 1997).

In an A–B–C single-case design, several factors other than the intervention can influence the dependent variables (Kazdin, 1982). An unavoidable confounding variable in this study was, for example, the way in which the changed housing itself affected mood, appetite, and eating habits. Assessing food intake during phase A might have heightened the awareness of staff, making them more attentive to what the resident was eating. This attention probably affected the residents' nutritional intake. Consequently, a nutritional intervention started already during phase A, which led to fulfilled energy requirements in most of the residents. To ensure internal validity, we recorded events that could influence the outcome, we used different outcome variables and we made all measurements continuously during the whole period. We investigated the generality of the findings by systematic replication. Because restoration of nutritional health is a slow process (Kinney *et al.*, 1968), a 3-month long phase B was chosen, which is similar to other studies (Larsson *et al.*, 1990; Thomas *et al.*, 1991; Tkatch *et al.*, 1992). For the same reason, the interval of 4 weeks between the first and second phase C measurements was chosen in order to detect possible nutritional changes.

The nutritional activities used in this study were simple, cheap and freely available in care homes. In municipal care, the registered nurse has a central role in identifying older people at risk of malnutrition, and organizing nutritional support adjusted for individual desires, gastrointestinal function, unique nutritional needs, and disease-specific requirements. By using the care plan together with a menu with the resident's calculated energy requirement marked as a goal, and by recording energy intake, the residents, their relatives and the staff can easily follow the result. An energy intake below energy requirement signals that attention is required and change in the care plan might be needed. In this study, one of the researchers (LCH) had an active role in identifying nutritional problems, planing the activities, and implementing the intervention. The next step will be to make the nutritional programme a part of ordinary care, independently managed by the staff.

Conclusion

A nutritional intervention programme based on individual needs, resources, and problems, with individual and available goals was devised. This had an affect on anthropometric measurements, serum protein concentration, and functional capacity in 10 out of 11 residents assessed as protein-energy malnourished on admission to municipal care.

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