PAPERS AND SHORT REPORTS

Bacterial contamination of the small intestine is an important cause of occult malabsorption in the elderly

A McEVOY, J DUTTON, O F W JAMES

Abstract

A study was conducted to examine the contribution that occult malabsorption makes to malnutrition among elderly patients admitted to an acute geriatric ward. Malnutrition was defined by anthropometric, haematological, and biochemical measurements.

Out of 490 patients, 55—many of whom had presented with non-gastrointestinal symptoms—were found to be malnourished. In 31 poor diet alone was probably the cause, but in the remaining 24 patients previously unrecognised malabsorption was detected. Of these patients, 17 were found to have bacterial contamination of the small bowel (nine with duodenojejunal diverticula, four after gastric surgery, and four diagnosed as contamination with "no sump"). In 10 patients contamination was confirmed by culture of intestinal juice: Escherichia coli was predominant in nine cases, and anaerobic organisms in one. Small bowel bacterial overgrowth without a "blind loop" or obvious underlying cause has not previously been fully proved in the elderly. Coeliac disease was detected in two patients, and chronic pancreatitis in two.

Occult malabsorption is an important cause of malnutrition in the elderly. Such malnutrition not infrequently occurs in geriatric patients presenting to hospital with non-specific symptoms of physical deterioration.

Introduction

Physicians and others concerned with the care of the elderly have very little idea of the prevalence of biochemical undernutrition in elderly patients,[1] and systematic investigation for causes of malabsorption with clinical, anthropometric, haematological, and biochemical evidence of undernutrition has rarely been carried out.[2 3] Furthermore, among nutritionists and gastroenterologists there is little reference to old age, either in the definition of normal nutrition or with regard to the study of the causes of malabsorption—the standard publication on normal anthropometric measurements in adults excludes people aged over 65[4]—and there is no reference to malabsorption in elderly subjects in two current standard works on gastroenterology.[5 6]

We have carried out a prospective study evaluating the nutritional state of all patients admitted to a geriatric assessment ward over two years. All patients found to have evidence of poor nutrition received a detailed dietary history and were investigated for a possible cause of malabsorption.

Methods

PATIENTS

All patients aged over 65 admitted to a general geriatric assessment unit between 1 January 1980 and 31 December 1981 were studied. Patients were admitted to the unit either after referral for assessment by general practitioners, or after attendance at a geriatric day unit when their problems were thought to require hospital admission, or as a result of transfer from one of several acute medical wards in Newcastle upon Tyne to which all patients with medical emergencies are admitted regardless of age. The principal reasons for admission were recorded. Two types of patients were excluded from the study—(*a*) those known or found to have malignant disease contributing to undernutrition—for example, patients admitted with physical deterioration and found to have gastric or pancreatic carcinoma—and (*b*) those with previously known digestive disorders who happened to be over 65. (Such patients attending the gastroenterology clinic and requiring admission for their disease—for example, inflammatory bowel disease or chronic pancreatitis—were admitted to the gastroenterology unit.)

NUTRITIONAL ASSESSMENT

Clinical examination—A thorough general clinical examination was carried out on all patients.

Anthropometric measurements—All patients had height, weight, triceps skinfold thickness, and mid-arm circumference measured. Arm muscle circumference was derived from triceps skinfold thickness and mid-arm circumference according to the relation: mid-arm

Freeman Hospital, Newcastle upon Tyne NE7 7DN
A McEVOY, MRCP, senior registrar in geriatric medicine
J DUTTON, FIMLS, laboratory scientist, department of bacteriology
O F W JAMES, FRCP, consultant physician

Correspondence to: Dr O F W James, Department of Medicine, Freeman Hospital, Newcastle upon Tyne NE7 7DN.

circumference − (triceps skinfold thickness × 0·314) = arm muscle circumference. All measurements were performed by a single experienced observer (AMcE). Triceps skinfold thickness was measured using Harpenden skinfold callipers at the mid-point between the acromion and olecranon. The mean of two measurements was taken. Mid-arm circumference was measured at the same level. Triceps skinfold thickness, mid-arm circumference, and arm muscle circumference were compared with indices previously defined in normal healthy subjects over 65.[7]

Haematological and biochemical studies—The following investigations were used as a "nutrition screen" in all patients (normal values in parentheses): haemoglobin concentration (< 12·0 g/dl), mean cell volume (80-98 fl), serum albumin concentration (< 34 g/l), and corrected serum calcium concentration (< 1·15 mmol/l; < 2·25 mmol/l).

DEFINITION OF MALNUTRITION

Malnutrition was defined as weight below 85% of ideal for height; values below 85% of defined normal in at least two of triceps skinfold thickness, mid-arm circumference, and arm muscle circumference; plus a value below normal in at least one haematological or biochemical measurement.

DIETARY ASSESSMENT

All patients found to have evidence of possible malnutrition as defined above received a dietary assessment by a staff dietitian. This included a full dietary history and, when necessary, an interview with the patient's relatives or neighbours and a visit to the patient's home. An inadequate diet was defined as an estimated daily energy intake of less than 6·3 MJ (1500 kcal), of which at least 10% was derived from protein.[8]

INVESTIGATIONS OF CAUSES FOR POSSIBLE MALABSORPTION

Subjects with malnutrition in whom dietary assessment showed no apparent abnormality or in whom poor dietary intake alone was not thought to be a sufficient cause of malnutrition received the following investigations: (*a*) barium meal and follow through examination of the small bowel; (*b*) ^{14}C-glycocholic acid breath test; (*c*) upper gastrointestinal endoscopy, endoscopic biopsy of the second part of the duodenum, and aspiration of juice from the second part of the duodenum or beyond for bacteriological culture and measurement of volatile fatty acids; (*d*)—if results of investigations (*a*) to (*c*) proved negative—endoscopic retrograde cholangiopancreatography and measurement of red cell folate and serum vitamin B_{12} concentrations (plus intrinsic factor and parietal cell antibodies); (*e*) ^{14}C-triolein breath test for fat malabsorption[9,10] (and a three day faecal fat estimation when the patient's general condition and faecal continence allowed).

BACTERIOLOGY

Small bowel aspirate for bacteriological culture was obtained endoscopically. The endoscope was sterilised in iodine and the suction channel flushed with sterile water. After the endoscope had been introduced into the gastrointestinal tract no suction was applied until it reached the desired area for aspiration. If a known possible site of overgrowth was present, such as duodenal diverticula, then aspiration was performed at that site when possible. Where there was no such sump aspiration was performed as distally as possible, usually in the third part of the duodenum or proximal jejunum. The aspirate was obtained by passing a sterile catheter down the endoscope channel and applying suction with a sterile 30 ml syringe. Care was taken not to inject air into the bowel during the procedure, so that anaerobic growth would not be inhibited. On completion of the aspiration the syringe was capped with a sterile hub and immediately sent to the laboratory.

The sample was digested with dithiothreitol (Sputolysin, Calbiochem-Behring) and inoculated on to a range of culture media.[11,12] These were: (*a*) MacConkey's agar (without NaCl); (*b*) Columbia/blood agar; (*c*) nalidixic acid blood agar; and (*d*) neomycin blood agar. Media (*a*) and (*b*) were incubated aerobically and media (*c*) and (*d*) anaerobically. All organisms were isolated by standard methods to species level. Finally, aliquots of the sample were placed in wells of lawn plates seeded with the Oxford staphylococcus and *Bacteroides fragilis* in order to exclude the possibility that inhibitory substances were inadvertently present.

The validity of this method had been confirmed by culture of small bowel contents of 13 elderly subjects undergoing endoscopy for other reasons. In none of these patients was a significant ($< 10^4$ organisms) growth obtained.

VOLATILE FATTY ACIDS

As a further test for anaerobic organisms, volatile fatty acid concentrations in the small bowel aspirate were measured by gas-liquid chromatography using the method of Chernov *et al.*[13]

Results

Of 490 patients admitted to the geriatric unit over the two years, 55 were found to have malnutrition; in 31 patients poor diet alone was thought to be responsible, but in 24 patients a cause for malabsorption was detected. Table I lists the main complaints leading to admission. In most patients several factors had led to admission but

TABLE I—*Main presenting complaints leading to hospital admission in 55 patients found to have malnutrition. (Many patients had more than one main presenting complaint)*

	All patients (n = 55)	Poor diet (n = 31)	Malabsorption (n = 24)
"Off feet"	15	8	7
"Diarrhoea"	15	10	5
Weight loss	13	8	5
Mental deterioration	7	3	4
Chest infection	6	1	5
Bone pain	6	3	3
Abdominal pain	4	3	1
Anorexia	4	0	4
Heart failure	3	0	3
Gangrene	1	0	1

the table lists only the major immediate problem or problems necessitating hospital admission. The category "off feet" is familiar to all those dealing with acutely ill elderly patients.[14] Some old people take to their bed or chair and become increasingly difficult to mobilise; the cause is often multifactorial, but the resultant immobility leads to urgent hospital admission, particularly of those who live alone. No significant difference in presenting problems existed between patients with poor diet alone and those with malabsorption.

Table II gives the details and results of investigations in the 24 patients in whom a cause for previously unrecognised malabsorption was detected. The diagnosis of coeliac disease in two patients was made on the basis of subtotal small intestinal villous atrophy with appropriate cellular infiltrate and with clinical improvement on a gluten free diet. No repeat biopsy or gluten challenge was carried out.

Chronic pancreatitis was diagnosed as a result of highly suggestive appearances of an irregular main pancreatic duct, irregular side ducts, and poor emptying of the pancreatic duct system.[15]

Two patients (cases 23 and 24) with abnormal ^{14}C-triolein breath test values and evidence of severe malnutrition with no dietary insufficiency refused further investigations. One of these had increased faecal fat excretion and the other bone *x* ray appearances highly suggestive of osteomalacia and an abnormal ^{14}C-glycocholic acid breath test result. One extremely confused patient (case 22) with the scar of a long forgotten abdominal operation was subsequently found to have had a massive small intestinal resection many years earlier for an unknown cause.

PATIENTS WITH BACTERIAL CONTAMINATION

Among the 17 patients in whom a diagnosis of bacterial contamination of the small bowel was made (cases 5-21; table II) the diagnosis was established as follows.

Duodenojejunal diverticula (cases 5-13)—All nine patients had an abnormal ^{14}C-glycocholic acid breath test result, and three in whom duodenal juice was aspirated showed abnormal bacteriological growth.

TABLE II—*Presumed diagnosis in 24 patients found to have malnutrition thought to be due to malabsorption*

Case No	Diagnosis	Triolein (normal value > 0·39 % dose/ mmol/l/ kg body wt	Faecal fat (normal value < 17 g/24 h)	Gastrointestinal appearances on radiology	^{14}C-glycocholic acid breath test result	Small bowel aspirate	Other
1	Coeliac disease	0·09	33·0	NAD	N	Negative	Total villous atrophy
2	Coeliac disease	0·37	56·0	NAD	N	Negative	Total villous atrophy
3	Chronic pancreatitis	0·38	55·0	NAD	N	ND	ERCP—"chronic pancreatitis"
4	Chronic pancreatitis	0·20	33·0	NAD	N	ND	ERCP—"chronic pancreatitis"
5	Bacterial contamination. Duodenal diverticula	0·17	11·5	Duodenojejunal diverticula	↑	*E coli, Klebsiella*	
6	Bacterial contamination. Duodenojejunal diverticula	0·43	ND	Duodenojejunal diverticula	↑	ND	
7	Bacterial contamination. Duodenojejunal diverticula	0·29	ND	Duodenojejunal diverticula	↑	ND	
8	Bacterial contamination. Duodenojejunal diverticula	0·48	ND	Duodenojejunal diverticula	↑	ND	
9	Bacterial contamination. Duodenojejunal diverticula	0·25	9·3	Duodenal diverticula	↑	*E coli*	
10	Bacterial contamination. Duodenojejunal diverticula	0·29	ND	Duodenojejunal diverticula	↑	Anaerobes	↑ Volatile fatty acids
11	Bacterial contamination. Jejunal diverticula	ND	ND	Jejunal diverticula	↑	ND	
12	Bacterial contamination. Jejunal diverticula	0·19	15·0	Jejunal diverticula	↑	ND	
13	Bacterial contamination. Jejunal diverticula	0·31	8·0	Jejunal diverticula	↑	ND	
14	Bacterial contamination after gastric surgery	0·17	ND	Gastroenterostomy	↑	*E coli*	
15	Bacterial contamination after gastric surgery	0·33	ND	Polya gastrectomy	↑	*E coli*	
16	Bacterial contamination after gastric surgery	0·34	27·0	Gastroenterostomy	↑	*E coli, Klebsiella*	
17	Bacterial contamination after gastric surgery	0·30	45·0	Gastroenterostomy	N	*E coli*	
18	Bacterial contamination. "No sump"	0·47	6·0	Normal	↑	*Klebsiella, E coli*	
19	Bacterial contamination. "No sump"	0·22	10·0	Normal	↑	ND	
20	Bacterial contamination. "No sump"	0·34	16·3	Normal	↑	*E coli*	
21	Bacterial contamination. "No sump"	0·35	ND	Normal	↑	*E coli, Klebsiella*	
22	Short bowel	0·36	56·0	Small bowel resection	↑	ND	
23	?	0·26	23·0	ND	ND	ND (refused)	
24	?	0·27	Refused	"Osteomalacia." Barium studies ND	↑	Refused	

ND = Measurement or test not done. NAD = No appreciable disease. N = Normal. ↑ = Abnormal result. ERCP = Endoscopic retrograde cholangiopancreatography.
Conversion: SI to traditional units—Triolein: 1 mmol/l ≈ 88·5 mg/100 ml.

Blind loop after gastric surgery (cases 14-17)—Three of the four patients had an abnormal ^{14}C-glycocholic acid breath test result, and in all four patients duodenal juice aspirates grew abnormal bacteriological flora.

Contamination with "no sump" (cases 18-21)—All four patients had an abnormal ^{14}C-glycocholic acid breath test result, and the three in whom duodenal juice was aspirated showed abnormal bacteriological growth; the fourth patient (case 19) in whom only the breath test result was available showed a grossly abnormal value.

BACTERIOLOGY

Among the 10 patients in whom positive small intestinal aspirates ($< 10^5$ organisms of at least one pathogenic species) were obtained *Escherichia coli*, often of several species, was aspirated in nine, and in four of these *Klebsiella* ($< 10^5$ organisms) were also obtained. In only one patient was a significant growth of anaerobic organisms obtained ($8{\cdot}0 \times 10^5$). Interestingly this was the only aspirate in which detectable concentrations of volatile fatty acids were also observed (propionate 1120 μmol/l, butyrate 135 μmol/l).

RESULTS OF TREATMENT

All patients were treated with vitamin B_{12}, folic acid, and iron if appropriate; all received vitamin supplements; and, in addition to a normal diet, supplements of an easily assimilated oral feed (usually Carnation Build Up) were given where necessary. Patients with bacterial contamination received oxytetracycline 250 mg three times a day for one month, then 250 mg daily thereafter; those in whom no clinical progress was seen after one month received clindamycin 150 mg twice daily for one month and 75 mg/day thereafter. Patients with coeliac disease started a gluten free diet; patients with chronic pancreatitis received Nutrizym (2 tablets with meals). The clinical outcome in such elderly patients was difficult to define precisely, but table III notes the place of discharge and mortality.

TABLE III—*Plan of discharge after treatment*

	Patients with malabsorption	Patients with dietary insufficiency
Home	20	15
Part III accommodation	4	9
Long stay	0	7
Total	24	31
Deaths since discharge (mean follow up 15 months)	1	6

Discussion

SELECTION OF PATIENTS

We do not claim that this study in any way represents the true incidence of malabsorption in patients over 65 admitted to hospital; nor do we claim that the range of conditions seen (including 17 out of 24 patients with bacterial contamination of the small intestine) is a true reflection of the diseases causing malabsorption in all people aged over 65 in Western countries. There were two important forms of selection in our "sample." Firstly, the geriatric unit to which the patients were referred is attached to a gastrointestinal unit in a teaching hospital, and the geriatric unit is known locally to be interested in malnutrition; hence the proportion of 55 out of 490 patients admitted to the geriatric unit and found to have malnutrition was probably higher than might be encountered elsewhere. Secondly, because patients with known gastrointestinal disorders before hospital admission and those found to have cancer (particularly gastrointestinal cancer) were specifically excluded from the study it cannot be thought to represent the true range of gastrointestinal diseases found in people over 65.

A quite different balance of diseases was found, for example,

by Price *et al*,[16] who analysed their experience of patients over 65 presenting to a gastrointestinal unit with diarrhoea who were shown to have steatorrhoea. In their study of 16 patients, four were found to have coeliac disease, seven presumed chronic pancreatitis, three presumed bacterial contamination (one with jejunal diverticula), and two tropical sprue. A similar preponderance of possible pancreatic disease or coeliac disease was found by Ryder in an earlier study of elderly patients with symptoms of steatorrhoea.[17] The only study of which we are aware that was slightly comparable to ours was that of Montgomery *et al*.[3] While their study was primarily designed to assess the functional efficiency of the aging small intestine, they also examined the possible role of malabsorption in old people in Britain with nutritional deficiencies, notably oesteomalacia. In 15 patients with malabsorption four had duodenal diverticulosis, two had had gastric surgery, and a further four were presumed to have bacterial contamination of the small intestine, although in only one was juice from the small intestine sampled for bacteriological study.

CLINICAL PRESENTATION

Our study does serve to draw attention to the fact that occult malnutrition may be an important factor leading to hospital admission in elderly patients suffering from a wide variety of often non-specific complaints (table I). Although 15 out of 55 patients had diarrhoea as a major problem leading to admission, 13 weight loss, six bone pain, and four abdominal pain, more non-specific symptoms—off feet (15), mental deterioration (seven), chest infection (six)—were also common. We could not distinguish on the basis of presenting symptoms between patients with malnutrition due to malabsorption and those in whom malnutrition appeared to be due to poor diet alone. In some instances patients with poor diet also had bacterial contamination of the small bowel; these have been included in the malabsorption group.

DIAGNOSIS OF MALABSORPTION

We classified 24 patients as having malabsorption on two grounds. Firstly, all patients had either an abnormal ^{14}C-triolein breath test or increased three day faecal fat excretion or both. Secondly, all except two patients (cases 23 and 24), in whom investigation was incomplete, had a definite cause for malabsorption detected by appropriate investigations. All such investigations carried out among the 31 patients in whom malnutrition was ascribed to poor diet alone gave negative results. Results of faecal fat estimations and ^{14}C-triolein breath tests, where carried out, were normal in the poor diet group.

FAECAL FAT VERSUS ^{14}C-TRIOLEIN BREATH TEST

Newcomer *et al* compared the triolein breath test with faecal fat estimation and found an extremely good correspondence between the two tests of fat malabsorption.[9]

In our study both tests gave abnormal results in all four patients with coeliac disease or chronic pancreatitis. Among the 17 patients with bacterial contamination, 12 out of 16 had an abnormal ^{14}C-triolein breath test result; only two out of nine tested had raised three day faecal fat estimations. We believe that this apparent disparity between the ^{14}C-triolein breath tests and three day faecal fat estimations was caused by the fact that shortly after admission to hospital many of these elderly patients were incontinent of faeces, thus making complete collections hard to obtain; furthermore, many could not at first take a large enough oral intake of fat in their diet to provide a reliable indication of faecal fat excretion. No patients were obese, nor were any overtly diabetic; thus we believe that the abnormal ^{14}C-triolein breath test results are more reliable indicators of fat malabsorption than "normal" faecal fat estimations in these circumstances.[10] Bacterial contamination of the small intestine, regardless of its cause, may lead to malnutrition without steatorrhoea, so that it is not surprising that fat malabsorption did not occur in every subject.

BACTERIAL CONTAMINATION

Early publications on malabsorption caused by classic "blind loop" syndrome drew attention to the role of anaerobic organisms in steatorrhoea.[18 19] But now, while the underlying mechanisms of malabsorption in bacterial contamination syndrome are still far from clear,[20] the important role of *E coli* organisms in producing such malabsorption is no longer in dispute.[21 22] It is noteworthy that anaerobic organisms as detected by culture and measurement of volatile fatty acids were responsible for malabsorption in only one subject in the present study. Gracey[23] recently summarised the many publications drawing attention to the fact that malnutrition itself, particularly in children, may lead to small bowel bacterial contamination (particularly with *E coli* species) and that this may cause malabsorption. It may well be, therefore, that the elderly with malnutrition due to poor diet are also more susceptible to such bacterial contamination.

We have previously described five elderly patients in whom we believed a bacterial contamination of the small intestine without a blind loop was responsible for malnutrition.[24] Of the four further patients described in the present group, small intestinal juice was aspirated in three, and in all three a profuse growth of several species of *E coli* was obtained. The mechanism for this bacterial contamination without blind loop is not clear. Possibly hypochlorhydria allows entry of the organisms into the small intestine from the stomach; possibly impaired peristalsis or pre-existing poor nutrition allows proliferation of the organisms and consequent mucosal damage.[22]

The role of duodenal diverticula in the pathogenesis of bacterial contamination in the elderly is interesting. It is incontrovertible that duodenal diverticula alone do lead to bacterial contamination and consequent malabsorption.[25 26] Duodenal diverticula, however, occur with increased frequency in old age and in many instances there is no evidence that such diverticula are causing any appreciable malabsorption.[27] It is therefore important not to assume that finding a diverticulum or diverticula on barium meal examination inevitably implies bacterial contamination and malabsorption. In the present series all nine patients with duodenal or jejunal diverticula had malnutrition, all had abnormal ^{14}C-glycocholic acid breath test results implying bacterial deconjugation of bile acids, and in all four in whom aspiration was carried out in or near a diverticulum an abnormal bacterial flora was obtained.

TREATMENT

There appeared to have been a difference in outcome after treatment between the patients with malnutrition associated with malabsorption and those with malnutrition due to dietary deficiency alone. Each group received similar nutritional support, specific causes for malabsorption also being treated as appropriate. It may well be that the poorer clinical outcome and higher subsequent mortality among the group with dietary insufficiency alone was due to the fact that the causes which led them to take an insufficient diet (dementia, depression, social isolation) made subsequent return home more difficult. The importance of accurate diagnosis in patients with malabsorption is underlined by the fact that 20 of the 24 patients—many admitted to hospital in a poor general condition—were able to return home; none needed long stay hospital care.

Conclusion

Finally, we suggest that a more systematic approach to the assessment of possible malnutrition should be adopted in hospitals dealing with admission of acutely ill elderly patients. The detection of occult malabsorption is neither very time consuming nor extremely traumatic for the individual patients. After initial clinical evaluation and a simple haematological and biochemical work up the diagnosis of occult malabsorption may usually be made by a barium meal and follow through examination plus the ^{14}C-glycocholic acid breath test.

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Dorsal column stimulation in multiple sclerosis: effects on bladder and long term findings

C H HAWKES, R BEARD, D FAWCETT, E A PAUL, D G T THOMAS

Abstract

The effect of dorsal column stimulation on bladder function in 15 patients with established multiple sclerosis was analysed by urodynamic tests. Significant improvement in flow rate and urethral sphincter pressure was recorded in about two thirds. Of 31 patients examined over five years only 13 showed initial benefit from stimulation and were given permanent stimulators; of these, only three appeared to receive lasting benefit. Early complications occurred in nine patients and five had a relapse of their disease.

These results suggest that at present stimulation of the dorsal column does not have a place in the routine management of multiple sclerosis.

Institute of Neurology, Queen Square, London
C H HAWKES, MD, MRCP, honorary clinical assistant, department of neurosurgical studies
E A PAUL, MSC, statistician, department of statistics and computer studies
D G T THOMAS, MRCP, FRCS, senior lecturer and consultant neurosurgeon

Worthing Hospital, Sussex
R BEARD, FRCS, consultant urologist

Charing Cross Hospital, London
D FAWCETT, FRCS, senior urological registrar

Correspondence to: Dr C H Hawkes, Department of Neurology, Ipswich Hospital, Ipswich IP4 5PD.

Introduction

Three years ago[1] we presented our initial findings of dorsal column stimulation in 19 selected patients with confirmed multiple sclerosis. The most convincing effect was on bladder control, although this was slight. We have since extended our observations, selecting particularly those patients with known bladder disorder amenable to examination.

Patients and methods of assessment

We studied 15 patients with multiple sclerosis. Three were included in our earlier publication.[1] All conformed to the "definite" group of Schumacher *et al*,[2] were aged under 55 years, and their condition was clinically stable for at least six months before the trial; they were