PAPERS AND SHORT REPORTS

Assessment of cardiac risk 10 days after uncomplicated myocardial infarction

V MICHAEL JELINEK, IAN G McDONALD, WILLIAM F RYAN, ROBERT W ZIFFER, ALEXIA CLEMENS, JUDITH GERLOFF

Abstract

A total of 188 patients with uncomplicated acute myocardial infarction (long-term Norris prognostic index 3·2) were rapidly mobilised, underwent a symptom-limited exercise test around the day of discharge from hospital (day 10), and returned to work at a median of six weeks after the acute event. The incidence of cardiac death six months, one year, and three years after infarction was 2·7%, 4·5%, and 7·3% respectively, and the corresponding figures for recurrent heart attacks were 3·4%, 8·2%, and 18·5% respectively. The risk of recurrence of heart attack was predicted by three variables assessed at discharge—namely, a history of classical effort angina ($p < 0·01$), radiological heart failure ($p < 0·05$), and angina induced by the exercise test ($p < 0·05$). The presence of any of these risk factors defined a group of patients with a sevenfold risk of recurrent heart attacks within six months of the initial acute infarct.

It is concluded that these risk factors identify a group of patients with a high risk of recurrence early after infarction, in whom vigorous secondary prophylaxis is desirable.

Introduction

Patients who show no evidence of unstable ischaemia, arrhythmia, or cardiac failure on the second or third day after acute myocardial infarction may be regarded as having an uncomplicated acute myocardial infarction. Such patients are suitable for rapid mobilisation and early discharge from hospital.[1 2] Patients with uncomplicated acute myocardial infarction attending our hospital-based cardiac rehabilitation unit were submitted to symptom-limited exercise tests near the day of discharge from hospital.[3] These showed that such patients have an almost normal effort tolerance at this stage, so we concluded that they are fit for most work, leisure, and sexual activity by the time of their discharge from hospital.[4] Because these patients have minimal disability and a good prognosis we restricted our secondary prevention measures to stopping smoking and controlling weight and blood pressure.

If we could define a group at high risk for recurrence of heart attack we might consider recommending the use of beta-blockers, sulphinpyrazone, or vein bypass surgery.[5–11] In this study we analysed our experience with 188 patients with uncomplicated acute myocardial infarction to define factors indicating a high risk of recurrence of heart attacks.

Patients and methods

The diagnosis of myocardial infarction was based on the occurrence of any three of the following: (1) a history of typical ischaemic chest pain of at least 30 minutes' duration; (2) sequential ST and T-wave changes of acute myocardial infarction; (3) the presence of pathological Q waves (one patient had left bundle-branch block); and (4) evolution of serum activities of both creatine phosphokinase and aspartate transaminase consistent with a diagnosis of acute myocardial infarction. Patients with myocardial infarction were excluded if they (1) experienced recurrent ischaemic chest pains; (2) had required treatment for hypotension, oliguria, or physical signs and radiological features of pulmonary venous congestion; or (3) had been receiving treatment for continuing major arrhythmias 48 hours after admission to the coronary care unit. All patients included in this study underwent a symptom-limited exercise test within 30 days of the acute myocardial infarction. Table I lists the important characteristics of the patients.

Although some of the patients were managed privately or at other hospital clinics, most were seen in consultation at the multidisciplinary cardiac rehabilitation unit. As previously described[4] we emphasised the primary importance of stopping cigarette smoking, reducing weight, and following a walking programme. Drugs were confined to those needed for treatment of hypertension and angina.

Cardiac Rehabilitation Unit, Cardiac Investigation Unit, and Melbourne University Department of Medicine, St Vincent's Hospital, Melbourne, Australia

V MICHAEL JELINEK, MD, FRACP, physician in charge, cardiac rehabilitation unit
IAN G McDONALD, MD, FRACP, director, cardiac investigation unit
WILLIAM F RYAN, MB, FRACP, visiting physician, cardiac rehabilitation unit
ROBERT W ZIFFER, MB, FRACP, medical registrar
ALEXIA CLEMENS, BA, social worker, cardiac rehabilitation unit
JUDITH GERLOFF, B APP SC, medical technician

TABLE I—*Characteristics of patients with recurrence of heart attack (n=28) compared with those of patients without recurrence (n=160). (Figures are numbers (%) of patients)*

	Recurrence of heart attack	No recurrence
Age (years)	51·0 ± 8·3	50·8 ± 7·7
Day of exercise test	11·2 ± 6·6	10·6 ± 6·0
Week of return to work	6·6 ± 3·2	6·7 ± 4·6
History:		
Prior angina	11 (39)*	26 (16)
Prior myocardial infarct	6 (21)	26 (16)
Findings on radiography:		
Cardiomegaly	8 (29)	21 (13)
Pulmonary congestion	16 (57)	60 (37·5)
Heart failure	7 (25)	12 (7·5)
Type of infarction on electrocardiography:		
Anterior transmural	5 (18)	50 (31)
Inferior transmural	12 (43)	67 (42)
Anterior non-transmural	8 (29)	25 (16)
Inferior non-transmural	2 (7)	17 (11)
Other	1 (4)	1 (1)
Exercise test:		
Test angina	10 (36)*	26 (16)
ST depression of 1 mm	8 (29)	37 (23)
ST depression of 2 mm	4 (14)	21 (13)
Variables measured at maximum exercise (means ± SD):		
Maximum work load (%)†	80·0 ± 12·6	88·9 ± 16·4
Maximum heart rate (beats/min)	140·4 ± 17·0	140·4 ± 21·8
Maximum systolic arterial blood pressure (mm Hg)	175·6 ± 27·1	168·9 ± 26·0
Maximum heart rate × maximum systolic blood pressure ($\times 10^{-2}$)	239·6 ± 48·6	240·5 ± 62·7

*$p < 0.05$ (χ^2 analysis).
†Maximum work load measured as percentage of that predicted for age, sex, and size.

The 188 patients studied had a mean Norris coronary prognostic index for long-term survival of 3·2[12]; they were discharged after a mean period of 9·8 days, underwent exercise testing at a mean of 10·7 days, and returned to work at a mean of 6·7 weeks after their infarction.

EXERCISE TESTING

Exercise testing was performed on a calibrated electrically braked bicycle ergometer. Modified leads V4, V5, and V6 were used for monitoring as previously described.[3] After the initial arterial blood pressure had been recorded with a sphygmomanometer and the initial heart rate by electrocardiography the patient started exercise at a work load of 25 W. The blood pressure, heart rate, and electrocardiogram were recorded and the work load increased by 25 W every minute. The patient usually stopped exercise because he felt exhausted. The test was stopped by the physician only if the patient developed typical angina of moderate severity, although in one case the test was stopped for three-beat ventricular tachycardia.

Immediately after the test the patient lay on a couch. During and after the test he was repeatedly interrogated for symptoms that might be angina. Test angina was defined as any pain or discomfort in the upper body (usually the precordium) that first appeared during or immediately after the exercise test, had other characteristics compatible with angina, and disappeared within 10 minutes after exercise was stopped.

The total duration of exercise, maximum heart rate, maximum arterial blood pressure, exercise electrocardiogram, and any symptoms during exercise were recorded. The exercise electrocardiogram was regarded as positive if the ST segment showed 1 mm or more of horizontal or downsloping depression below the PR segment. The maximum work load was compared with the predicted work load derived from a study of Australian subjects of the same age, sex, and size.[13]

CLINICAL CHARACTERISTICS

Clinical characteristics were extracted from the patients' records by either RWZ or JG before any follow-up. Effort angina before myocardial infarction was diagnosed if walking or hurrying had evoked retrosternal pain that had forced the patient to stop or slow and had been relieved by rest within 10 minutes. Ischaemic pain experienced only at rest was not included as angina preceding myocardial infarction. The criteria for diagnosis of previous myocardial infarction were the same as those for acute myocardial infarction. The routine report of the radiology department was used to assess heart size and lung fields in the coronary care unit. Radiological heart failure was defined as the presence of both cardiomegaly and pulmonary congestion on the chest *x*-ray film.

FOLLOW-UP

Subsequent outcome was obtained in most cases by VMJ from the standard protocol at the cardiac rehabilitation unit or the hospital record. AC followed up difficult cases by contact with medical practitioners and employers and by home visits. Patients entered the study between March 1975 and October 1979. All survivors were contacted between January 1979 and May 1980. Thus the 188 patients were followed up for from 10 days to 62 months.

Sudden cardiac death was defined as death occurring a few minutes after the onset of symptoms; it occurred out of hospital in all cases. The criteria for recurrent myocardial infarction were the same as those for admission to the study. Cardiac death was defined as sudden cardiac death or death with recurrent acute myocardial infarction. Recurrent heart attack was either sudden cardiac death or recurrent myocardial infarction. Secondary risk factors were those categorical variables that were significantly associated on χ^2 analysis with recurrence of the heart attack.

Results

Clinical course after myocardial infarction—The 188 patients were followed up for a mean of 27·0 months (median 26 months). In that time 28 had recurrent heart attacks. Six patients sustained sudden cardiac deaths, five fatal acute myocardial infarctions, two sudden cardiac death late after recurrent infarction, and 15 non-fatal myocardial infarction. One additional patient died from carcinoma of the pancreas 12 months after acute myocardial infarction and was classified as a survivor without recurrent heart attack at that time. The incidence of cardiac death at six months and three years was 2·7% and 7·3% respectively; the corresponding figures for recurrent heart attack were 5·4% and 18·5% respectively (fig 1).

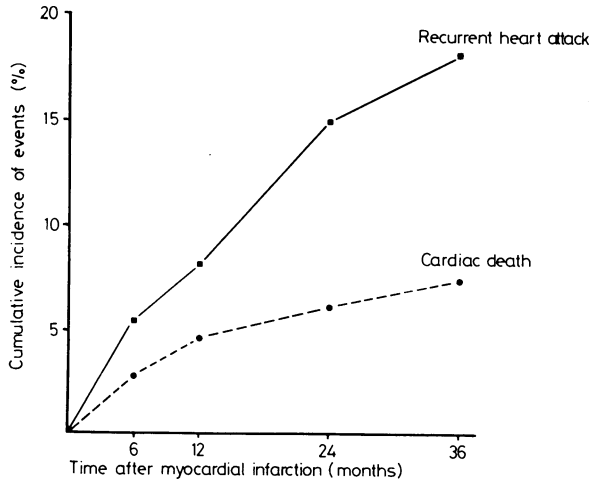

FIG 1—Cumulative incidence of cardiac death and recurrence of heart attack after uncomplicated acute myocardial infarction.

Secondary risk factors for recurrence of heart attack (table II)—Three secondary risk factors were identified—namely, a history of effort angina before acute myocardial infarction ($p < 0.01$), the occurrence of angina on exercise testing ($p < 0.05$), and radiological heart failure ($p < 0.05$). Twenty-one of the 25 patients with ≥ 0.2 mV of ST-segment depression on exercise had experienced an acute inferior myocardial infarction ($p < 0.01$). This finding was not associated with an increased incidence of recurrence of heart attack in these patients. At least one risk factor was found in 19 (68%) of the patients who had subsequent heart attacks compared with 48 (30%) of the patients who did not ($p < 0.001$). The contribution of each risk factor to the

detection of high risk was about equal (table II). In patients with any risk factor the risk of recurrence within six months was 11·6% and within three years 32·8%. By contrast, in patients without any of the risk factors the risk of recurrence within six months was 1·7% and within three years 10·0%. Thus patients with risk factors had a sevenfold risk of recurrence of heart attack within six months of the acute myocardial infarction.

TABLE II—*Secondary risk factor state and risk of cardiac recurrence after uncomplicated acute myocardial infarction*

Risk factor state			No in subgroup	No with recurrence*	Absolute risk of recurrence	Relative risk of recurrence
History of angina pectoris	Angina induced by exercise test	Radiological heart failure				
0	0	0	121	9 (5)	0·074	1
+	0	0	15	4 (2)		
0	+	0	15	3 (1)		
0	0	+	14	5 (3)		
+	+	0	18	5 (1)	0·283	3·8
+	0	+	2	0 (0)		
0	+	+	1	0 (0)		
+	+	+	2	2 (1)		

*Numbers in parentheses indicate number of cardiac deaths in each subgroup.

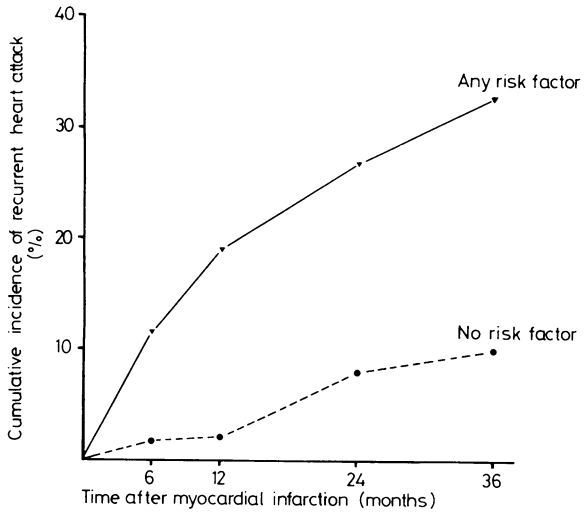

FIG 2—Cumulative incidence of recurrence of heart attack in patients with and without secondary risk factors (see text).

Discussion

Our patients underwent early symptom-limited exercise tests as part of a rehabilitation programme designed to minimise the financial and employment sequelae of uncomplicated acute myocardial infarction. Although the patients returned to work earlier than is usual,[14] the incidences of cardiac death and recurrence at three years were 7·3% and 18·5% respectively—that is, about half the figures reported by Norris for patients with a similar prognostic index.[12 15]

Three independent risk factors indicated a high risk of recurrence in these patients: radiological heart failure in the coronary care unit; a history of effort angina preceding acute myocardial infarction; and angina induced by exercise testing 10 days after myocardial infarction.

Radiological heart failure—In this study we deliberately excluded patients whose clinical, electrocardiographic, and radiological state necessitated treatment for left ventricular dysfunction. Thus we excluded patients with myocardial infarction who were most at risk of premature death soon after discharge from hospital.[12 16–23] Heart failure present on only radiological grounds, however, was associated with a fourfold risk of recurrent heart attack. Battler *et al* recently re-emphasised the importance of subtle radiological signs occurring in the coronary care unit in patients with acute myocardial infarction.[24]

Angina before myocardial infarction—Although it is conventional to describe ischaemic chest pain as anginal in the unstable phase, which may precede acute myocardial infarction,[25] we regarded pain before myocardial infarction as anginal only if it met Rose's criteria for effort angina.[26] This was because our previous analysis had shown that anginal pain that is clearly evoked by walking or hurrying is more closely associated with multivessel coronary artery disease[27] and premature cardiac death[28] than is the occurrence of rest pain. Other workers have found that classical effort angina preceding first myocardial infarction is associated with an excess risk of recurrent heart attack especially in the first few months after myocardial infarction.[29 30]

Angina on exercise testing 10 days after myocardial infarction—There have been no previous reports on the prognostic importance of symptom-limited exercise testing 10 days after myocardial infarction. Nevertheless, our observation that patients exhibiting test angina had almost a threefold increase in the incidence of recurrent heart attack is consistent with our previous reports indicating the superiority of evaluation of symptoms to ST-segment analysis in the diagnosis[27] and prognosis[28] of patients with chest pain.

Several studies have indicated the striking predictive power of ST-segment depression on exercise testing after myocardial infarction.[31–33] The differences in these studies from ours in the composition of the patients studied, exercise testing, and time of testing after acute myocardial infarction may account for our not being able to show any prognostic importance in the movement of the ST segment on exercise testing. Recently, Borer *et al* found no relation between ST depression on exercise and subsequent mortality.[34]

Thus we prospectively identified a group of patients with acute myocardial infarction suitable for early mobilisation, early discharge from hospital, early symptom-limited exercise testing, and early return to work. The incidence of cardiac death among this group of patients at six months and three years was 2·7% and 7·3% respectively. Retrospective analysis of the data indicated three secondary risk factors for recurrent heart attack —namely, effort angina before myocardial infarction, angina induced by an exercise test 10 days after infarction, and radiological heart failure in the coronary care unit. The presence of any of these risk factors defined a group of patients with a sevenfold risk of recurrent heart attack within the first six months after discharge from hospital. Vigorous pharmacological or surgical treatment should be offered to such patients in an attempt to improve this prognosis.

References

1 Swan HJC, Blackburn HW, de Sanctis RW, *et al.* Duration of hospitalization in "uncomplicated completed acute myocardial infarction." An ad hoc committee review. *Am J Cardiol* 1976;**37**:413-9.

2 Anonymous. Mobilisation after myocardial infarction. *Br Med J* 1977;ii:651.

3 Jelinek VM, Ziffer RW, McDonald IG, Wasir H, Hale GS. Early exercise testing and mobilization after myocardial infarction. *Med J Aust* 1977;**2**:589-93.

4 Jelinek VM, Ziffer RW, McDonald IG, Hale GS. Shortened cardiac rehabilitation: a three year experience. *Aust NZ J Med* 1980;**10**:171-5.

5 Wilhemsson C, Wilhemsen L, Vedin JA, Tibblin G, Werko L. Reduction of sudden deaths after myocardial infarction by treatment with alprenolol. *Lancet* 1974;ii:1157-60.

6 Ahlmark G, Sawtre H, Korsgren M. Reduction of sudden deaths after myocardial infarction. *Lancet* 1974;ii:1563.

7 Multicentre International Study. Improvement in prognosis of myocardial infarction by long term beta-adrenoreceptor blockade using practolol. *Br Med J* 1975;iii:735-40.

8 Andersen MP, Bechsgaard P, Fredricksen J, *et al.* Effect of alprenolol on mortality among patients with definite or suspected acute myocardial infarction. *Lancet* 1979;ii:865-8.

9 Anturane Reinfarction Trial Research Group. Sulphinpyrazone in the prevention of sudden death after myocardial infarction. *N Engl J Med* 1980;**302**:250-6.

[10] Takaro T, Hultgren HN, Lipton MJ, Detre KM. The VA cooperative randomised study of surgery for coronary arterial occlusive disease. II. Subgroup with significant left main lesions. *Circulation* 1976;**54**,suppl 3: 107-17.
[11] European Coronary Surgery Study Group. Coronary artery bypass surgery in stable angina pectoris: survival at two years. *Lancet* 1979;i: 889-93.
[12] Norris RM, Caughey DE, Deeming LW, Mercer CJ, Scott PJ. Coronary prognostic index for predicting survival after recovery from acute myocardial infarction. *Lancet* 1970;ii:485-7.
[13] Calvert AF, Bernstein L, Bailey IK. Physiological responses to maximal exercise in a normal Australian population—comparative values in patients with anatomically defined coronary artery disease. *Aust NZ J Med* 1977;**7**:497-506.
[14] Wenger NK, Hellerstein HK, Blackburn H, Castranova SJ. Uncomplicated myocardial infarction. Current physician practice in patient management. *JAMA* 1973;**224**:511-4.
[15] Norris RM, Mercer CJ. Long term prognosis following treatment in a coronary care unit. *Aust NZ J Med* 1973;**3**:31-7.
[16] Peel AAF, Semple T, Wang I, Lancaster WM, Dall JLG. A coronary prognostic index for grading the severity of infarction. *Br Heart J* 1962; **24**:745-60.
[17] Helmers C. Short and long-term prognostic indices in acute myocardial infarction. *Acta Med Scand* [*Suppl*] 1973;**555**:1-86.
[18] Bigger JT, Heller CA, Wenger TL, Weld FM. Risk stratification after acute myocardial infarction. *Am J Cardiol* 1978;**42**:202-10.
[19] Thompson PL, Fletcher EE, Katavatis V. Enzymatic indices of myocardial necrosis; influence on short and long term prognosis after myocardial infarction. *Circulation* 1979;**59**:113-9.
[20] Geltman EM, Ehsan AA, Campbell MK, Schechtman K, Roberts R, Sobel BE. The influence of location and extent of myocardial infarction on long-term ventricular dysrhythmia and mortality. *Circulation* 1979; **60**:805-14.
[21] Davis HT, Decamilla J, Bayer LW, Moss AJ. Survivorship patterns in the post hospital phase of myocardial infarction. *Circulation* 1979;**60**:1252-8.
[22] Luria MH, Knocke JD, Wachs JS, Luria MA. Survival after recovery from acute myocardial infarction. Two and five year prognostic indices. *Am J Med* 1979;**67**:7-14.
[23] Battler A, Slutsky R, Karliner J, Froelicher V, Ashburn W, Ross J Jr. Left ventricular ejection fraction and first and third ejection fraction early after acute myocardial infarction: value for predicting mortality and morbidity. *Am J Cardiol* 1980;**45**:197-202.
[24] Battler A, Karliner JS, Higgins CB, *et al.* The initial chest X-ray in acute myocardial infarction. Prediction of early and late mortality and survival. *Circulation* 1980;**61**:1004-9.
[25] Unstable Angina Pectoris Study Group. Unstable angina pectoris national cooperative study group to compare medical and surgical therapy. I. A report of the protocol and patient population. *Am J Cardiol* 1976;**37**: 896-902.
[26] Rose GA. The diagnosis of ischaemic heart pain and intermittent claudication in field surveys. *Bull WHO* 1962;**27**:645-58.
[27] Jelinek VM, McDonald IG, Schweitzer P, Herman MV, Gorlin R. Exercise testing in the detection of severe coronary artery disease. *Aust NZ J Med* 1978;**8**:361-5.
[28] Jelinek VM, McDonald IG. History, exercise test and prognosis of chest pain. *Med J Aust* 1980;**2**:25-7.
[29] Beard OW, Hipp HR, Robins M, Taylor JS, Ebert RV, Beran LG. Initial myocardial infarction among 503 veterans. Five-year survival. *Am J Med* 1960;**28**:871-83.
[30] Weinblatt E, Shapiro S, Frank CW, Sager RV. Prognosis of men after first myocardial infarction; mortality and first recurrence in relation to selected parameters. *Am J Public Health* 1968;**58**:1329-47.
[31] Hunt D, Baker G, Hamer A, Pennington C, Duffield A, Sloman G. Predictors of reinfarction and sudden death in a high risk group of acute myocardial infarction survivors. *Lancet* 1979;i:233-6.
[32] Theroux P, Waters DD, Halphen C, Debaisieux JC, Mizgala HF. Prognostic value of exercise testing soon after myocardial infarction. *N Engl J Med* 1979;**301**:341-6.
[33] Sami M, Kraemer H, De Busk RF. The prognostic significance of serial exercise testing after myocardial infarction. *Circulation* 1979;**60**:1238-46.
[34] Borer JS, Rosing DR, Miller RH, *et al.* Natural history of left ventricular function during 1 year after acute myocardial infarction: comparison with clinical, electrocardiographic and biochemical determinations. *Am J Cardiol* 1980;**46**:1-12.

(*Accepted 2 October 1981*)

Clostridium difficile in association with sporadic diarrhoea

R P BRETTLE, I R POXTON, J McC MURDOCH, R BROWN, MARIE D BYRNE, J G COLLEE

Abstract

A total of 154 patients admitted to an infectious diseases unit were included in a year's prospective survey of sporadic diarrhoeal disease. Stools from 19 of them yielded Clostridium difficile, generally on more than one occasion. Twelve of these patients were assessed as having a severe or moderately severe gastrointestinal illness: Cl difficile was the only pathogen isolated from 10 of them, and two had an associated salmonella infection. Seven had had a recent course of antibiotics, but five had not taken antibiotics. Faeces from seven patients with moderate or mild gastrointestinal illness yielded Cl difficile, and two of these patients also had an associated salmonella infection. Two patients in this group had no antibiotic history.

From these findings, the occurrence of C difficile in faeces could not be described as antibiotic-associated. Faecal Cl difficile cytotoxin was detected in only six patients, and generally at low levels. In such patients a more relevant pathogenic index might take account of the numbers of Cl difficile present and of their toxigenic potential.

Department of Infectious Diseases, City Hospital, Edinburgh EH10 5SB

R P BRETTLE, MRCP, senior registrar
J McC MURDOCH, FRCP, consultant physician

Department of Bacteriology, University Medical School, Edinburgh EH8 9AG

I R POXTON, BSC, PHD, lecturer
J G COLLEE, MD, FRCPATH, professor
R BROWN, FIMLS, chief medical laboratory scientific officer
MARIE D BYRNE, BSC, AIMLS, medical laboratory scientific officer

Introduction

Though a pathogenic association between *Clostridium difficile* and pseudomembranous colitis is accepted, the role of this organism in intestinal health and disease in infants and adults is still uncertain.[1] The development of better selective culture procedures has greatly facilitated the isolation of *Cl difficile* from stools.[2] We have therefore conducted a prospective study to determine the range of circumstances in which *Cl difficile* may be detected and possibly implicated in sporadic cases of diarrhoea in adults admitted during one year to an infectious diseases hospital.

Patients and methods

We included in the survey all patients admitted to the infectious diseases unit during November 1979 to October 1980 who presented with diarrhoea or developed diarrhoea. During the study period there was no recognised epidemic of gastroenteritis or diarrhoeal