C Reactive protein and its relation to cardiovascular risk factors: a population based cross sectional study

M A Mendall, Praful Patel, Lydia Ballam, D Strachan, T C Northfield

Abstract

***Objective*—To test the hypothesis that minor chronic insults such as smoking, chronic bronchitis, and two persistent bacterial infections may be associated with increases in C reactive protein concentration within the normal range and that variations in the C reactive protein concentration in turn may be associated with levels of cardiovascular risk factors and chronic coronary heart disease.**

***Design*—Population based cross sectional study.**

Setting—General practices in Merton, Sutton, and Wandsworth.

***Subjects*—A random sample of 388 men aged 50-69 years from general practice registers. 612 men were invited to attend and 413 attended, of whom 25 non-white men were excluded. The first 303 of the remaining 388 men had full risk factor profiles determined.**

***Interventions*—Measurements of serum C reactive protein concentrations by in house enzyme linked immunosorbent assay (ELISA); other determinations by standard methods. Coronary heart disease was sought by the Rose angina questionnaire and Minnesota coded electrocardiograms.**

***Main outcome measures*—Serum C reactive protein concentrations, cardiovascular risk factor levels, and the presence of coronary heart disease.**

***Results*—Increasing age, smoking, symptoms of chronic bronchitis, *Helicobacter pylori* and *Chlamydia pneumoniae* infections, and body mass index were all associated with raised concentrations of C reactive protein. C Reactive protein concentration was associated with raised serum fibrinogen, sialic acid, total cholesterol, triglyceride, glucose, and apolipoprotein B values. C Reactive protein concentration was negatively associated with high density lipoprotein cholesterol concentration. There was a weaker positive relation with low density lipoprotein cholesterol concentration and no relation with apolipoprotein A I value. C Reactive protein concentration was also strongly associated with coronary heart disease.**

***Conclusion*—The body's response to inflammation may play an important part in influencing the progression of atherosclerosis. The association of C reactive protein concentration with coronary heart disease needs testing in prospective studies.**

Division of Biochemical Medicine, St George's Medical School, London SW17 0RE
M A Mendall, *senior lecturer*
Praful Patel, *research fellow*
Lydia Ballam, *research assistant*
T C Northfield, *professor*

Public Health Sciences, St George's Medical School, London SW17 0RE
D Strachan, *senior lecturer*

Correspondence to:
Dr Mendall.

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Introduction

The acute phase response is part of the body's reaction to injury or infection. It is associated with changes in lipid and glucose metabolism. Concentrations of high density lipoprotein cholesterol consistently fall[1] and glucose and triglyceride concentrations rise.[2-4] Inconsistent changes in total cholesterol and apolipoprotein B values have been observed, possibly due to the timing of sampling and the different pathological conditions studied.[2 4-6] Apolipoprotein A I concentration does not change, and low density lipoprotein cholesterol concentration falls a little. The cellular and rheological properties of blood change, with an increase in white cell and platelet counts. There is an increase in synthesis of proteins such as fibrinogen by the liver which increase coagulability and the viscosity of the blood. All these changes have been shown to be associated with cardiovascular disease in prospective studies. Sialic acid is found in association with many acute phase proteins and in one prospective study was a powerful predictor of coronary heart disease.[7]

C Reactive protein is the major acute phase protein in humans. In unchallenged subjects concentrations are usually low, rising several hundredfold in acute illness.[8] The causes of variation in C reactive protein concentrations in otherwise normal people have received little attention. Raised concentrations of C reactive protein have been associated with smoking[9] and aging.[10] By using a comparatively insensitive nephelometric method we have shown that two chronic bacterial infections—*Helicobacter pylori* (a persistent cause of gastric inflammation) and *Chlamydia pneumoniae* (a respiratory pathogen)—are associated with raised concentrations of C reactive protein and raised levels of inflammatory mediators within conventional normal ranges.[11] Other chronic exposures which could be important include periodontal disease and chronic bronchial inflammation. All these exposures have been linked to coronary heart disease.[12-14]

The relation between cardiovascular risk factors and serum C reactive protein concentrations within conventional reference ranges in otherwise normal people has also received little attention. Associations between C reactive protein concentration and serum fibrinogen concentration have been observed in normal elderly people[15] and between C reactive protein concentration and fasting serum insulin concentration in patients with chronic coronary heart disease.[16] These findings suggest that low levels of inflammatory activity may produce qualitatively similar effects to those seen during acute illness or injury.

In patients with unstable angina and in chronic coronary heart disease C reactive protein concentration may be a powerful predictor of subsequent cardiac events.[17 18] It is unknown, however, whether C reactive protein is a risk factor for chronic coronary heart disease in comparison with general population controls, as

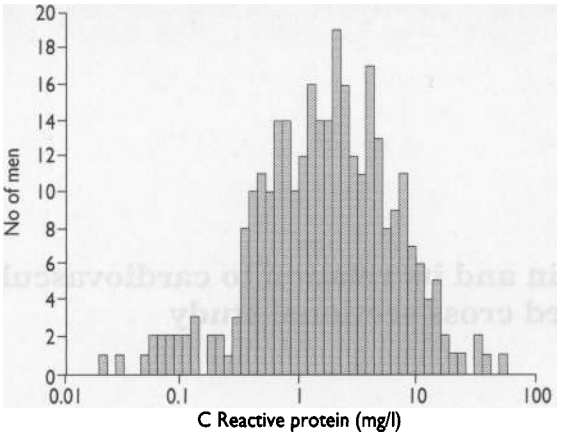

Fig 1—*Log_{10} transformed distribution of C reactive protein in randomly sampled population of 303 men aged 50-69*

available tests have not been sensitive enough to detect low serum concentrations reliably.

We tested the hypothesis that chronic exposures causing low grade inflammation are associated with variations in C reactive protein concentration within the normal range in the general population and that these variations may be associated with differences in levels of various cardiovascular risk factors and the presence of coronary heart disease in middle aged men.

Subjects and methods

We recruited a random sample of men aged 50-69 years from the registers of general practices in the Merton, Sutton, and Wandsworth District Health Authority area, south London. A total of 612 men were invited and 413 (67%) attended. Of these, 25 were non-white and were excluded. Information was obtained on history and symptoms of coronary heart disease, lifestyle, and socioeconomic circumstances, as described previously. Cardiovascular risk factor profiles and serological tests for *H pylori* and *C pneumoniae* were also performed as described.[11] Electrocardiograms were Minnesota coded. We took tracings to indicate coronary heart disease if they showed any of the following: Q waves, ST segment depression, left bundle branch block, or T wave inversion. Only the 303 men who had complete cardiovascular risk factor profiles were included in the study.

C Reactive protein concentration was measured by in house enzyme linked immunosorbent assay (ELISA). Rabbit antihuman C reactive protein (Dako) was used to coat the plates at a concentration of 10 mg/l. Test serum was then added at dilutions of between 1 in 100 and 1 in 1000. C Reactive protein was detected with peroxidase conjugated rabbit antihuman C reactive protein at a dilution of 1 in 6000 (Dako) and a standard detection method used. The assay was standardised against international standard 85/506 C reactive protein. The standard curve was linear up to 5 μg/l and logarithmic thereafter. The interassay and intra-assay coefficients of variation were 14% and 8%. The proportional recovery derived from spiking serum samples with standards was 94%(range 85-104%).

The distribution of C reactive protein concentrations was positively skewed and hence C reactive protein concentration was log transformed for all analyses. Log C reactive protein concentration was analysed as the outcome variable in relation to age, smoking, chronic infection, and body mass index and as an explanatory variable in relation to cardiovascular risk factors and prevalent cardiovascular disease.

The relation of log C reactive protein concentration to age, smoking, chronic infection, and body mass index was analysed by multiple regression in Stata (Stata Corporation, United States). All determinants were controlled for each other and for the subject's social class (registrar general's classification I, II, IIINM (non-manual), IIIM (manual), IV, V) and father's social class (I, II, IIINM, IIIM, IV, V, unclassified).

Regression models for the association of log C reactive protein with cardiovascular risk factors included as explanatory variables age as a continuous variable; smoking (never smoker, former smoker, current smoker); pack years of smoking; current daily cigarette consumption; subject's social class; and father's social class. High density lipoprotein cholesterol, triglyceride, glucose, and apolipoprotein A I and B concentrations; white cell count; ratio of total cholesterol to high density lipoprotein cholesterol; and ratio of apolipoprotein B to apolipoprotein A I were log transformed as they had a positively skewed distribution. The relation between C reactive protein concentration and cardiovascular diseases was analysed by logistic regression in Stata.

Results

Figure 1 shows the distribution of C reactive protein concentrations in our population. The median value was 1.72 mg/l (interquartile range 0.69-3.95 mg/l). There was an approximate doubling in C reactive protein concentration between adjacent fifths of the distribution.

Relation of environmental factors and inflammation to serum C reactive protein concentration—Table 1 shows the prevalence of potential determinants of C reactive pro-

Table 1—*Prevalence of exposures by fifths of C reactive protein distribution in 303 men aged 50-69. Figures are numbers (percentages) of subjects [SE]*

	Fifth of C reactive protein distribution (mg/l)					
	0.02-0.59 (median 0.36) (n=61)	0.60-1.27 (median 0.85) (n=61)	1.28-2.39 (median 1.73) (n=60)	2.40-4.63 (median 3.45) (n=61)	4.64-51.64 (median 7.99) (n=60)	t†
Father's occupation manual	37 (61.0) [6.3]	37 (61.0) [6.3]	45 (75.0) [5.6]	51 (84.0) [4.8]	45 (75.0) [5.6]	2.935**
Own occupation manual	32 (53.0) [6.4]	22 (36.0) [6.2]	38 (63.0) [6.3]	34 (56.0) [6.4]	31 (52.0) [6.5]	0.858
Current smoker	10 (16.4) [4.8]	14 (23.0) [5.4]	20 (33.3) [6.1]	20 (33.0) [6.1]	20 (33.0) [6.1]	2.283*
Ever smoked	42 (69.0) [6.0]	47 (77.0) [5.4]	45 (75.0) [5.6]	51 (84.0) [4.8]	50 (83.0) [4.9]	2.213*
Three months of phlegm yearly	7 (11.5) [4.1]	8 (13.0) [4.4]	18 (30.0) [6.0]	18 (30.0) [5.9]	20 (34.0) [6.2]	3.863***
H pylori seropositivity	24 (39.0) [6.3]	26 (43.0) [6.4]	33 (55.0) [6.5]	37 (61.0) [6.3]	33 (55.0) [6.5]	2.708**
C pneumoniae seropositivity	9 (15.0) [4.6]	7 (12.0) [4.2]	15 (25.0) [5.6]	16 (27.0) [5.8]	15 (24.0) [5.6]	2.364*
Abnormal electrocardiogram	3 (5.0) [2.8]	6 (10.0) [3.8]	5 (8.0) [3.6]	13 (21.0) [5.3]	14 (23.0) [5.5]	3.414***
History of angina or myocardial infarction	1 (1.6) [1.6]	8 (13.0) [4.4]	7 (12.0) [4.2]	11 (18.0) [5.0]	19 (32.0) [6.1]	4.001***
Abnormal electrocardiogram plus history of angina or myocardial infarction	3 (5.0) [2.0]	9 (15.0) [4.6]	9 (15.0) [4.6]	18 (30.0) [5.9]	26 (43.0) [6.5]	4.929***
Claudication	1 (1.6) [1.6]	1 (1.6) [1.6]	5 (8.0) [3.6]	7 (12.0) [4.1]	10 (17.0) [4.9]	3.633***

* P<0.05. ** P<0.01. *** P<0.001.

† Unpaired *t* test comparing log_{10} C reactive protein values in groups with and without risk factors.

Table 2—*Determinants of C reactive protein concentration analysed by multiple regression with C reactive protein log_{10} transformed. Coefficients are expressed as relative increase in C reactive protein per unit change in explanatory variable*

	Unadjusted relative increase in C reactive protein per unit increase in explanatory variable (95% confidence interval)	P	Adjusted relative increase in C reactive protein per unit increase in explanatory variable (95% confidence interval)†	P
Age (per 10 years)	1.43 (1.10 to 1.87)	<0.01	1.48 (1.09 to 2.00)	<0.01
Phlegm for 3 months (yes *v* no)	1.99 (1.42 to 2.79)	<0.0001	1.68 (1.13 to 2.23)	<0.01
Current smoker (*v* never)	1.85 (1.23 to 2.77)	<0.01	1.64 (0.76 to 3.51)	0.20
Former smoker (*v* never)	1.46 (0.99 to 2.15)	0.06	0.78 (0.49 to 1.26)	0.30
Current cigarette consumption (per cigarette)‡	1.01 (1.00 to 1.03)	0.07	0.98 (0.94 to 1.01)	0.20
Pack years (per 10 pack years)§	1.12 (1.06 to 1.19)	<0.0001	1.09 (1.01 to 1.19)	<0.05
H pylori seropositivity (yes *v* no)	1.55 (1.16 to 2.07)	<0.01	1.36 (0.97 to 1.89)	0.07
C pneumoniae seropositivity (yes *v* no)	1.53 (1.06 to 2.20)	<0.05	1.40 (0.93 to 2.10)	0.10
Body mass index (kg/m^2)	1.08 (1.04 to 1.12)	<0.0001	1.10 (1.05 to 1.15)	<0.0001

† Variables mutually adjusted and adjusted for age, own current social class (six categories), and father's social class (six categories).
‡ Set to zero for current non-smokers.
§ Set to zero for lifelong non-smokers.

tein concentration by fifths of the distribution. Higher concentrations were associated with increasing age, smoking, history of chronic bronchitis, *H pylori* seropositivity, *C pneumoniae* seropositivity, and body mass index. Table 2 shows the effect of adjusting these factors for each other and for father's occupation and subject's current occupation. A strong independent relation was found with body mass index. Other variables independently associated with C reactive protein concentration were age and symptoms of chronic bronchitis, seropositivity to *H pylori* and *C pneumoniae* being rendered of borderline statistical significance. The most influential aspect of smoking related to pack years.

Relation of serum C reactive protein concentration to cardiovascular risk factors—Table 3 shows the relation between cardiovascular risk factors and C reactive protein concentration by fifths of the distribution. There were graded effects on most risk factors in a direction to increase risk except with low density lipoprotein cholesterol and apolipoprotein A I concentrations and diastolic blood pressure. After adjustment for age, social class, father's social class, smoking, and body mass index these relations persisted. Exceptions were the relation with blood pressure, which disappeared, and a relation with low density lipoprotein cholesterol, which appeared.

Relation between C reactive protein concentration and electrocardiographic abnormalities, symptomatic heart disease, and claudication—Forty one men had an abnormal electrocardiogram, 27 had a positive Rose angina questionnaire result or history of myocardial infarction alone, and 24 had symptoms of intermittent claudication. After adjustment for age, smoking, current and childhood social class, and body mass index the odds ratio per doubling of C reactive protein concentration was 1.36 (95% confidence interval 1.08 to 1.72) for electrocardiographic abnormalities, 1.42 (1.13 to 1.78) for subjects with a positive Rose angina questionnaire result or history of myocardial infarction (irrespective of electrocardiographic findings), 1.55 (1.25 to 1.92) for subjects with either (that is, all prevalent heart disease), and 1.83 (1.29 to 2.58) for subjects with claudication.

Discussion

So far as we know this is the first study to examine in detail the potential determinants of serum C reactive protein concentrations within the conventional reference range and to examine the relation of these concentrations to risk factors for cardiovascular disease. This is also the first population based study to show a relation between C reactive protein concentration and electrocardiographic abnormalities indicative of past or present coronary heart disease and symptoms of angina and claudication.

Serum C reactive protein concentration within conventional reference ranges is probably a reflection of the general level of inflammatory activity within the

Table 3—*Cardiovascular risk factors by fifths of C reactive protein distribution in study population. Figures are means (SD)*

	Fifth of C reactive protein distribution (mg/l)						
	0.02-0.59 (median 0.36)	0.60-1.27 (median 0.85)	1.28-2.39 (median 1.73)	2.40-4.63 (median 3.45)	4.64-51.64 (median 7.99)	††	‡‡
Age (years) (n=303)	57.2 (5.5)	58.5 (5.4)	58.2 (5.3)	60.9 (5.4)	59.6 (5.3)	2.8**	
Body mass index (kg/m^2) (n=303)	25.3 (3.4)	27.1 (3.6)	27.7 (3.3)	27.5 (3.8)	27.9 (4.6)	4.0***	
Sialic acid (g/l) (n=303)	0.63 (0.078)	0.66 (0.09)	0.69 (0.078)	0.75 (0.10)	0.84 (0.13)	10.7***	10.4***
Fibrinogen (g/l) (n=250)	2.46 (0.38)	2.56 (0.62)	2.63 (0.45)	2.89 (0.55)	3.18 (0.65)	6.2***	5.8***
Glucose (mmol/l) (n=303)§	5.14 (0.52)	5.16 (0.64)	5.51 (1.45)	5.99 (2.18)	6.04 (2.91)	2.8**	2.2*
Total cholesterol (mmol/l) (n=303)	5.38 (0.80)	6.10 (1.0)	6.03 (1.0)	6.03 (1.1)	6.27 (1.2)	4.4***	3.9***
Triglycerides (mmol/l) (n=284)§	1.21 (0.55)	1.64 (0.91)	1.68 (0.85)	1.87 (0.93)	1.92 (0.89)	5.4***	4.0***
High density lipoprotein cholesterol (mmol/l) (n=303)§	1.22 (0.27)	1.11 (0.30)	1.13 (0.34)	1.11 (0.30)	1.02 (0.28)	3.4***	2.3*
Low density lipoprotein cholesterol (mmol/l) (n=303)	1.37 (0.38)	1.57 (0.47)	1.49 (0.44)	1.38 (0.43)	1.52 (0.46)	1.5	2.2*
Total cholesterol/high density lipoprotein cholesterol (n=303)§	4.65 (1.21)	5.82 (1.66)	5.81 (1.94)	5.69 (1.43)	6.56 (2.22)	5.6***	4.2***
Apolipoprotein A I (g/l) (n=299)	1.68 (0.29)	1.60 (0.31)	1.61 (0.31)	1.62 (0.28)	1.61 (0.36)	1.2	0.2
Apolipoprotein B (g/l) (n=300)	1.23 (0.03)	1.49 (0.05)	1.49 (0.04)	1.49 (0.05)	1.59 (0.05)	5.6***	4.5***
Apolipoprotein B/A I (n=299)	0.75 (0.21)	0.97 (0.34)	0.96 (0.30)	0.95 (0.29)	1.03 (0.35)	4.9***	3.3**
Systolic blood pressure (mm Hg) (n=279)	129.5 (22.0)	133.2 (19.0)	129.7 (17.0)	137.7 (22.0)	135.8 (19.0)	2.4*	0.2
Diastolic blood pressure (mm Hg) (n=279)	80.7 (11.0)	82.7 (11.0)	81.1 (11.0)	81.8 (10.0)	82.1 (10.0)	1.1	0.4

* P<0.05. ** P<0.01. *** P<0.001.
† *t* Tests derived from simple linear regression of log_{10} C reactive protein on each risk factor separately.
‡ *t* Test derived from multiple linear regression of log_{10} C reactive protein concentration adjusting for age and body mass index (as continuous variables), social class (six categories), father's social class (six categories plus unknown), and smoking (current smoker, former smoker, current cigarette consumption, and pack years as continuous variables).
§ Variable was log_{10} transformed for simple and multiple linear regression analyses.

body. Three exposures which were related to the concentration of C reactive protein—namely, persistent phlegm, *H pylori* infection, and *C pneumoniae* infection—are associated with inflammation. The mechanism whereby smoking is related to C reactive protein concentration is unclear, but it may in part be mediated through bronchial injury or inflammation.

The production of C reactive protein is regulated by cytokines, principally interleukin 6,[19] whose effects are modified by other cytokines and growth factors[20] as well as by hormones such as cortisol and insulin.[21] Production of cytokines and other stress hormones may be altered in conditions other than inflammation or injury. Adipocytes from obese humans have been shown to overproduce tumour necrosis factor α messenger RNA.[22] Tumour necrosis factor α is a potent inducer of interleukin 6 production by various cells. This may explain why a high body mass index was associated with increased serum concentrations of C reactive protein.

Throughout the range of C reactive protein concentrations in this general population sample there was a strong graded relation with white cell count and total cholesterol, high density lipoprotein cholesterol, triglyceride, glucose, apolipoprotein B, fibrinogen, and sialic acid concentrations. The ratio of total cholesterol to high density lipoprotein cholesterol and of apolipoprotein B to apolipoprotein A I, which may be a better measure of cardiovascular risk,[23] also displayed strong graded relations. There were weak relations with systolic blood pressure and low density lipoprotein cholesterol concentration and none with apolipoprotein A I. Controlling for body mass index weakened the relations with lipid values only modestly and strengthened the relation with low density lipoprotein cholesterol concentration but had no effect on the relation of C reactive protein value with sialic acid and fibrinogen concentrations and white cell count. These relations between C reactive protein concentrations within the normal range and cardiovascular risk factors were qualitatively similar to those seen in better defined acute illness or injury, or in animal models,[6] supporting the notion that the acute phase response is a continuum and not an all or none response.

ROLE OF CYTOKINES

The association of C reactive protein concentration with cardiovascular risk factors could be explained by the actions of cytokines and other hormones which alter the concentrations of both. Interleukin 6 can increase hepatic synthesis of clotting factors and can also increase hepatic gluconeogenesis and triglyceride synthesis.[24] It also stimulates general haemopoiesis.[25] Tumour necrosis factor α has been strongly implicated in the pathogenesis of insulin resistance.[22 26] This underlies syndrome X, which is characterised by alterations in blood glucose and serum lipid concentrations in the same pattern as we observed in association with raised serum C reactive protein concentrations.[27] Tumour necrosis factor α also inhibits lipoprotein lipase activity and stimulates hepatic lipogenesis in rats.[24] The decrease in high density lipoprotein cholesterol concentration has been postulated to result from the redistribution of lipids in this fraction to other fractions, with apolipoprotein A I being displaced as the major apolipoprotein by serum amyloid A protein.[6] The cause of the rise in apolipoprotein B concentration in our subjects was uncertain.

The strong relation of C reactive protein concentration to claudication and electrocardiographic abnormalities may merely reflect tissue damage resulting from myocardial infarction. Our finding of a strong relation between C reactive protein concentration and chronic coronary heart disease of unspecified onset provides circumstantial evidence that C reactive protein concentration may relate to the underlying pathogenesis. This is supported by a reported relation between C reactive protein concentration and prognosis in patients with chronic stable angina.[18]

Serum C reactive protein concentration could be related to the pathogenesis of atherosclerosis via the effects of inflammation on conventional risk factors, or the raised C reactive protein concentration may result from inflammation in the arterial wall associated with the atherosclerosis itself. A further possibility is that the cytokine and cellular mediators of the acute phase response originating at a distance to the coronary arteries are directly involved in the pathogenesis of atherosclerosis.

What we need now are prospective studies to evaluate the association of C reactive protein concentrations with subsequent cardiac events and the extension of these observations to other age groups and to women. The relation between short term fluctuations in C reactive protein concentration and cardiovascular risk factors also requires evaluation. Further research could usefully explore the regulation of the acute phase response with respect to cytokines and their role as independent risk factors for coronary heart disease.

Key messages

- Recent studies suggest that levels of inflammatory mediators are important prognostic indicators in angina
- Factors that determine levels of inflammatory mediators in the normal general population have not been explored, nor has their relation to cardiovascular risk factors
- Among 50-69 year old men many environmental and lifestyle risk factors for cardiovascular disease are associated with raised serum concentrations of C reactive protein
- Circulating concentrations of lipids, glucose, and clotting factors are also associated with serum C reactive protein concentrations
- The body's response to inflammation may influence the development of atherosclerosis

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Psychiatric problems in children with hemiplegia: cross sectional epidemiological survey

Robert Goodman, Philip Graham

Abstract

***Objective*—To examine the prevalence and predictors of psychiatric problems in children with hemiplegia.**

***Design*—Cross sectional questionnaire survey of an epidemiological sample with individual assessments of a representative subgroup. The questionnaire survey was repeated on school age subjects four years later.**

***Subjects*—428 hemiplegic children aged 2½-16 years, of whom 149 (aged 6-10 years) were individually assessed.**

***Main outcome measures*—Psychiatric symptom scores and the occurrence of psychiatric disorder.**

***Results*—Psychiatric disorders affected 61% (95% confidence interval 53% to 69%) of subjects as judged by individual assessments and 54% (49% to 59%) and 42% (37% to 47%) as judged from parent and teacher questionnaires, respectively. Few affected children had been in contact with child mental health services. The strongest consistent predictor of psychiatric problems was intelligence quotient (IQ), which was highly correlated with an index of neurological severity; age, sex, and laterality of lesion had little or no predictive power.**

***Conclusion*—Though most hemiplegic children have considerable emotional or behavioural difficulties, these psychological complications commonly go unrecognised or untreated. Comprehensive health provision for children with chronic neurodevelopmental disorders such as hemiplegia should be psychologically as well as physically oriented.**

Department of Child and Adolescent Psychiatry, Institute of Psychiatry, London SE5 8AF
Robert Goodman, *reader in brain and behavioural medicine*

Behavioural Sciences Unit, Institute of Child Health, London WC1N 1EH
Philip Graham, *emeritus professor of child psychiatry*

Correspondence to:
Dr Goodman.

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Introduction

Previous clinical and epidemiological studies have shown that children with chronic cerebral disorders such as cerebral palsy have a substantially increased rate of emotional and behavioural difficulties—an increase far greater than that seen in chronic non-cerebral disorders that result in comparable disability and social impact.[1-3] About one in every 200 children in the general population has a psychiatric disorder in association with unequivocal brain disorders (primarily cerebral palsy, epilepsy, and severe mental retardation).[1] In many instances, the psychiatric problems result in more handicap and distress for the child and family than the physical or cognitive disabilities. A better understanding of brain-behaviour links may lead to improved treatment or prevention strategies.

Childhood hemiplegia may provide a particularly useful model for studying brain-behaviour links in childhood. Thus hemiplegia affects up to one child in 1000 and provides the opportunity to examine whether psychiatric consequences vary with the laterality of lesion or the age at onset (which ranges from the prenatal period to later childhood). As most affected children are of normal intelligence and attend mainstream schools, it is possible to examine psychiatric problems that are not secondary to intellectual impairment or segregated schooling. Finally, the relatively minor motor disability does not bar the use of ordinary psychiatric assessment techniques. When assessing hyperactivity, for example, it is no harder to ask about overactivity and fidgetiness in a hemiplegic child than in any ordinary child, whereas it would make little sense to ask the same questions about a child with athetoid cerebral palsy who was restricted to a wheelchair.

Subjects and methods

SUBJECTS

The London Hemiplegia Register used multiple sources to ascertain a representative sample of 458 London children with hemiplegia (plus three hemiplegic children who lived just outside the Greater London boundary).[4] The present study involved the 428 children who were aged 2½ to 16 years at the time of first assessment.

MEASURES

Questionnaire measures of psychiatric caseness were used for the entire age range,[5-8] with detailed individual psychiatric assessments being carried out on a representative subsample of the 6 to 10 year olds. Questionnaire measures of psychopathology corresponded well with comparable measures derived from individual assessments.[8] In the initial cross sectional survey, questionnaires completed by parents were obtained for 90% (386/428) of the sample,[5 8] and questionnaires completed by teachers (or other preschool professionals) were obtained for 89% (381/428),[6 7] with at least one questionnaire being obtained in all 428 cases. Because cross sectional data cannot be used to distinguish between age and cohort effects, additional longitudinal data are presented from a follow up of the same sample an average of four years later using the same parent and teacher questionnaires. A total of 328 children were eligible for follow up, being aged between 2½ and 12 years at the time of the initial survey and therefore still of compulsory school age four years later; parent questionnaires were obtained for 84% (276/328) of the