mild hypertension, and carbohydrate intolerance develop greater abnormality of these indices when on oral contraceptives compared with those in whom the initial levels were normal. If this turns out to be the case, then all women should be screened for these abnormalities before starting oral contraception.

With regard to the second question, identification in users of oral contraceptives of raised serum lipids or hypertension is desirable since these women should be advised to use other contraceptive measures, particularly if they also smoke cigarettes excessively or have had a rapid gain in weight.

All women on oral contraceptives should therefore be reviewed medically at regular intervals, certainly once a year. Their blood pressure and weight should be checked. Serum cholesterol should probably also be measured at least once during the first year after starting oral contraception, and figures above 270-300 mg./100 ml. indicate further investigation. Since there is doubt whether oral contraceptives have an adverse effect on carbohydrate tolerance (Clinch, Turnbull, and Khosla, 1969) and intolerance was not a feature of this series, it can probably be disregarded; at most, a postprandial check for glycosuria could be done annually.

I am grateful to Dr. Martin Vessey, Oxford, and Professor Victor Wynn, London, for their helpful advice in the preparation of this paper.

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Urban and Social Origins of Childhood Bronchitis in England and Wales

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British Medical Journal, 1970, **2**, 213–217

Summary: A survey of respiratory disease in over 10,000 children aged 6 to 10 years living in contrasting urban and rural areas of England and Wales showed pronounced social class gradient in the frequency of chronic cough, history of bronchitis, and also in disease of ears and nose. A consistent rise in the frequency of chest conditions with increasing local levels of air pollution was clearly seen only among the children of semi-skilled and unskilled workers. No such gradient was obvious for diseases of the ear and nose. These trends in chest disease in children paralleled similar trends in mortal and disabling bronchitis among adults in the same areas. The excess rate for bronchitis in children and adults found in South Wales could not be accounted for by local levels of air pollution.

Introduction

Evidence is accumulating that the level of bronchitis in early adult life depends in part on experience of respiratory disease in childhood and that environmental conditions, such as air pollution or other urban factors, may affect both chronic lung disease in adults and lower and perhaps upper respiratory tract disorders in children (Reid, 1969). In adults, however, smoking is of such importance that its effect obscures those of other environmental agents. Among children under the age of 11 years smoking has hardly begun (Todd, 1969). Surveys in children may thus show more clearly the influence of factors other than smoking on respiratory disease. Parental social class was important in the past (Grundy and Lewis-Fanning, 1957; Douglas and Bloomfield, 1958). Outside the home, urban conditions in general and air pollution in particular are of prime interest. Of such factors outside the home, urban conditions in general and air pollution in particular are of prime interest.

We here describe an inquiry conducted in collaboration with the school medical officers of the areas concerned (see below) on the prevalence of both upper and lower respiratory tract diseases in boys and girls aged 6 to 10 in relation to their past history, their home and social circumstances, and the air pollution level and other environmental features of the area where they lived. Samples of children attending primary schools in areas representing a wide range of urban and rural environments were chosen in England and Wales. In England, Bolton and Newcastle were selected as large cities with high levels of air pollution, Bristol and Reading as large cities with much lower levels, while parts of the rural areas of Lancashire, Northumberland, Northampton, Essex, and West Sussex were taken as typical districts with relatively low levels. In South Wales, where anthracite and similar coals are burned and smoke pollution is relatively low, Merthyr Tydfil and rural Glamorgan were surveyed.

Sampling Within Areas

To give balanced samples of adequate size, 500 children of each sex in each year of life from 6 to 10 years were selected in each area. In the rural areas all the children attending the local primary schools were included in the survey. In Northamptonshire, Essex, West Sussex, and Glamorgan a single rural district yielded about 1,000 children aged 6 to 10 years, but in Lancashire and Northumberland more than one rural district had to be covered to give this total. Some primary schools, in rural areas but drawing large numbers of children from near-by towns, were excluded. In Bolton and Newcastle, where some areas housed largely working-class or upper- and middle-class families, a primary school within

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each of these defined areas was randomly selected to ensure a broad spread of children in each social class. Random samples of primary schools were drawn without preliminary stratification in Bristol and Reading where the social classes were more evenly spread throughout the city. Because only a small proportion of children attend private or special primary schools, the samples drawn gave large and representative groups of children from different social classes living in different types of rural and urban area and fairly evenly balanced with respect to age and sex. That they were not necessarily a completely representative sample of all the children in these cities does not affect the within social class comparisons made below.

The study was carried out in September, October, and November 1966, at the end of the summer and before the winter peak in air pollution. This ensured that any urban: rural differences observed in respiratory disease prevalence were not the acute effects of transient exposure to high winter concentrations of pollutants in urban air.

A questionary sent in September to each parent asked for details of the child's current symptoms, his history of bronchitis, pneumonia, and other respiratory tract infections and specific fevers, the father's occupation, and some account of domestic circumstances. Each child was examined by one of the 30 school medical officers collaborating in the inquiry assisted by the school nurse. Ears and pharynx were inspected, and standing height, weight, and peak expiratory flow rate (using the Wright peak flow meter) were measured. The child was then asked to blow his nose into a disposable handkerchief to ascertain the presence and nature of any nasal discharge. The doctors concerned had attended briefing sessions to agree on clinical standards and followed a uniform protocol. Each centre was visited while the survey was in progress and examinations were repeated on subsamples of children in an attempt to standardize the clinical methods and criteria used. Each peak flow meter was calibrated and adjusted to match a standard meter.

The data given below derive from questions on upper and lower respiratory diseases, the results of examination of ears, and measurement of ventilatory function. Four of the questions were: (1) Does he/she usually cough during the day or at night in the winter? (chronic cough.) (2) Has he/she ever had bronchitis? (3) Has he/she ever had pneumonia? (4) Does he/she have a blocked or runny nose on most days of the year?

Response Rates

In only one area (West Sussex) was the response rate, at 82·0%, appreciably below the rest, and since the characteristics of the non-responders could not be readily established, the results from West Sussex are not included. From the 11,135 children registered in the primary schools selected in the remaining areas, 10,887 (97·8%) participated and the data on these children forms the basis of the analysis.

Upper and Lower Respiratory Tract Disease

A series of two-way classification tables were drawn up to determine whether any two clinical features occurred together more often than might have been expected by chance. The relative risk of a child suffering from, for example, chronic cough having ear disease compared with the risk in one without cough was estimated by calculating the cross-ratio in the two-way table for cough and ear disease. The results seen in Table I show that all these ratios are significantly above unity, so that the child with chronic cough is more likely to have either a history of past chest disease or signs of past or present upper respiratory disorder than is a child free from chronic cough. Similar associations seen in Table I underline the close interrelation of upper and lower respiratory disease in these children.

TABLE I.—*Association Between Indices of Respiratory Disease. Relative Risk of Presence of Both Indices*

	Past Bronchitis/ Pneumonia	Blocked Nose	Eardrum Perforation, Scar, or Discharge
Chronic cough	3·39‡	6·52‡	1·38†
Past bronchitis/pneumonia		2·36‡	1·20*
Blocked nose			1·38*

* $0·01<P<0·05$.
† $0·001<P<0·01$.
‡ $P\leqslant 0·001$.

Validity of the Questionary

The validity of the replies to questions on past and present history can be assessed by comparing the peak flow rates in the children responding either positively or negatively to them. Table II shows that after adjusting for age, height, and weight, and social class there is a gradient between the mean for children with neither previous bronchitis or pneumonia nor present chronic cough to a minimum level among children reporting both. This consistency between responses and ventilatory function gives some confidence in their value as indicators of respiratory disease.

TABLE II.—*Relationship Between Respiratory Disease History and Peak Expiratory Flow Rate (P.E.F.R.) Adjusted for Age, Height, and Weight, and Social Class*

Respiratory Disease History		Peak Flow Rate (l./min.)
Past Bronchitis/Pneumonia	Chronic Cough	
No	No	228*
No	Yes	225
Yes	No	222
Yes	Yes	213*

* $0·02>P>0·01$.
Other contrasts not significant.

Prevalence of Indices of Respiratory Disease

The frequency of three indices of respiratory disorder derived from the questionary among boys and girls aged 6 to 10 years is set out in Table III. The rates for past bronchitis and blocked nose are a little higher among boys, but the downward age trends are similar in the two sexes. The results of examining the ears are given in Table IV. The data for both sexes combined show a similar age trend for the presence of either perforation or scarring of the drum or discharge in either or both ears. Because of the similarity of rates and trends in boys and girls, the remaining tables are based on standardized morbidity ratios for the two sexes together. The overall age-specific rates have been applied to particular area or social class groups to derive a ratio (%) of the observed number of cases to that expected on the basis of these rates. The overall rate is taken as 100%.

The social classification used is a condensed form of that published by the Registrar-General and is based on the father's occupation (General Register Office, 1966): I and II, professional and managerial; III, skilled workers; and IV and V, semi-skilled and unskilled workers.

For some children without parental information (603) such a social classification was impracticable and they were not included in the later calculations.

TABLE III.—*Prevalence (%) of Indices of Respiratory Disease, by Age and Sex*

Age	Population*		Chronic Cough (%)		Past Bronchitis (%)		Blocked Nose (%)	
	Male	Female	Male	Female	Male	Female	Male	Female
6 ..	1,157	1,096	17	19	25	22	13	11
7 ..	1,106	1,106	14	15	25	20	13	10
8 ..	1,149	1,090	15	14	24	19	11	10
9 ..	1,119	1,063	13	13	23	20	12	9
10 ..	883†	930†	12	10	18	22	9	8
All ..	1,083	1,057	14	14	23	20	12	10

* Average number of completed responses to these specific questions.
† Owing to a misunderstanding 10-year-olds were not included in Newcastle.

TABLE IV.—*Prevalence of Ear Perforation, Scar, or Discharge in Either or Both Ears, by Age. Males and Females*

Age	Population Examined	Percentage With Perforation, Scar, or Discharge
6	2,260	7
7	2,220	7
8	2,253	6
9	2,193	6
10	1,803	5
All	10,729	6

Urban:Rural and Social Class Comparisons

The larger samples obtained by grouping data from the two northern cities, the two southern cities, and the rural areas in England allows a clear comparison between the rates of respiratory disease in children from the three social class groups living in different urban and rural environments.

Table V shows, in every area, a clear social class gradient from low rates in the children from professional and managerial families to the highest rates in those of semi--skilled and unskilled workers. Within each social grouping different geographic patterns emerge. Among the children of social classes I and II there is no difference in frequency of chronic cough between the rural areas and the urban areas of relatively low and high pollution, nor is there a clear trend among the children of social class III. But among the working-class families of social classes IV and V there is a clear gradient from the lowest rate in the rural areas to the highest in the more heavily polluted cities of Newcastle and Bolton. This apparent interaction between the effect of social class and urban conditions on chronic cough is illustrated in Fig. 1. The same relationships are obvious in respect of a history of bronchitis (Table V).

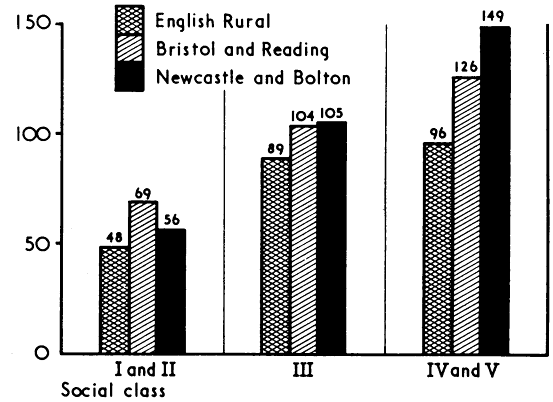

FIG. 1.—Age-adjusted morbidity ratios (S.M.R.%) for chronic cough (males and females, English areas).

Upper Respiratory Tract Infections

The social and geographic distribution of nasal obstruction and the finding of either discharge from the ear or perforation or scarring of either or both drums are set out in Table VI. As for chronic cough and a history of bronchitis there is a pronounced social class gradient for both manifestations of upper respiratory tract disease. There is, however, no consistent increase in prevalence of ear disease between the rural areas and the increasing degrees of pollution represented by the two pairs of cities, though rates for the more serious middle-ear disease are highest in Bolton and Newcastle where pollution is heavy. Apparent differences between areas may, however, result from differences in clinical standards in aural examination.

TABLE V.—*Cases and Age-adjusted Morbidity Ratios (S.M.R. %) for Chronic Cough and Past Bronchitis by Social Class for English Areas. Males and Females*

	Chronic Cough						Past Bronchitis					
	I and II		III		IV and V		I and II		III		IV and V	
	Cases	S.M.R.	Cases	S.M.R.	Cases	S.M.R.	Cases	S.M.R.	Cases	S.M.R.	Cases	S.M.R.
Newcastle and Bolton	17	56	184	105	118	149	31	69	268	104	145	124
Bristol and Reading	36	69	189	104	74	126	69	88	265	95	87	98
English rural	84	48	253	89	148	96	197	74	344	80	206	88

TABLE VI.—*Cases and Age-adjusted Morbidity Ratios (S.M.R. %) for Blocked Nose and Ear Disease by Social Class for English Areas. Males and Females*

	Blocked Nose						Ear Perforation, Scar, or Discharge					
	I and II		III		IV and V		I and II		III		IV and V	
	Cases	S.M.R.	Cases	S.M.R.	Cases	S.M.R.	Cases	S.M.R.	Cases	S.M.R.	Cases	S.M.R.
Newcastle and Bolton	12	54	138	109	80	139	23	177	155	207	88	259
Bristol and Reading	31	81	142	105	67	156	4	18	16	20	6	24
English rural	64	50	156	75	88	78	40	53	78	69	68	101

National Differences in Respiratory Disease

The results of the surveys in Merthyr Tydfil and rural Glamorgan are compared in Table VII, with the English urban and rural ratios. Perhaps because of the smaller numbers involved, the social class gradients already noted in England are consistently seen in the Welsh data only for chronic cough. Ratios for each clinical index, standardized for age and social class on the basis of the total experience, have therefore been calculated.

The most striking feature of childhood bronchitis in the two Welsh districts is the high rates for all respiratory complaints compared with corresponding rural and urban areas of England. Even among the children of rural Glamorgan past bronchitis and chronic cough are more frequent than in the large English cities of Bristol and Reading. Middle-ear disease is not, however, as common as in Bolton and Newcastle; but, again, clinical standards may differ.

Table VII.—*Age and Social Class Adjusted Morbidity Ratios (S.M.R. %) for Upper and Lower Respiratory Disease Indices. Males and Females*

	England			Wales	
	English Rural	Bristol and Reading	Newcastle and Bolton	Glamorgan	Merthyr Tydfil
Chronic cough	82	103	110	114	128
Past bronchitis	83	95	102	118	173
Blocked nose	72	115	110	104	164
Ear perforation, scar, discharge	76	21	215	101	124

Relation of Symptoms to Ventilatory Function

Despite rigorous attempts to ensure uniformity in meter calibration and application, differences between the areas surveyed in peak flow meter results may be obscured by variation in observer technique or in the response characteristic of the 70 peak flow meters used. Comparisons made within each area by the same observer using the same machine between those reporting chronic cough or other symptoms and those free from symptoms is unlikely to be affected in this way. It is shown in Table VIII that, after adjustment for age, height, weight, and social class, there is little difference between the five areas in the average levels of those with or without a history of either previous bronchitis or pneumonia or a current chronic cough. More important is the constancy of the percentage deficit in peak flow rate in those with the same history but living in different localities.

Table VIII.—*Peak Expiratory Flow Rate (P.E.F.R.) (l./min.), Adjusted for Age, Height, Weight and Social Class, in Those With and Without a History of Respiratory Disease, by Area*

	Past Bronchitis/ Pneumonia		% Difference ("No" minus "Yes")	Chronic Cough		% Difference ("No" minus "Yes")
	No P.E.F.R.	Yes P.E.F.R.		No P.E.F.R.	Yes P.E.F.R.	
Newcastle and Bolton ..	232 (1,357)	222 (449)	4	232 (1,518)	225 (285)	3
Bristol and Reading	233 (1,506)	224 (400)	4	233 (1,660)	222 (249)	5
English Rural ..	228 (3,308)	220 (770)	3	228 (3,630)	222 (441)	3
Merthyr Tydfil ..	234 (482)	226 (299)	3	233 (645)	224 (133)	4
Glamorgan	231 (688)	223 (262)	3	231 (808)	222 (143)	4

Numbers are given in parentheses.

This implies both that the disability associated with a particular symptom is not markedly greater in heavily polluted areas and that the symptoms reported have the same significance in Wales as in the rest of the areas surveyed.

Bronchitis in Adults and Children in Same Area

A parallelism between sickness and death from bronchitis among children and adults living in the same district could point to some aetiological factors affecting both age groups. The relative frequency of bronchitic history and symptoms among the children included in this survey have therefore been compared with official statistics of mortality (Registrar-General, 1967) and disabling morbidity among male adults in the same area. The latter were taken from the survey of absence from work due to bronchitis and other diseases carried out by the then Ministry of Pensions and National Insurance (1965).

These rates can be compared with estimated levels of air pollution (Warren Spring Laboratory, 1966, 1967a). Unfortunately, methods of assessing smoke and sulphur dioxide levels were not uniformly used in the areas surveyed. By using the regression line of the results of the lead dioxide method on those obtained by the hydrogen peroxide method (Warren Spring Laboratory, 1967b) estimates of sulphur dioxide concentrations were made for Merthyr Tydfil. There was no comparable calibration curve for deposit gauge measurements made in that town. The sulphur dioxide levels reported in our survey areas agree reasonably well with those for urban areas in the same regions given in the Ministry of Pensions and National Insurance (1965) report and they have been taken as an index of the level of air pollution in the districts surveyed. Measuring stations were sited in only two out of the five rural areas concerned in this study. Near-by sites were substituted in two of these areas but the estimates of rural pollution are inevitably even more imprecise than in the urban areas.

Despite these imperfections, Fig. 2 shows, in England, a

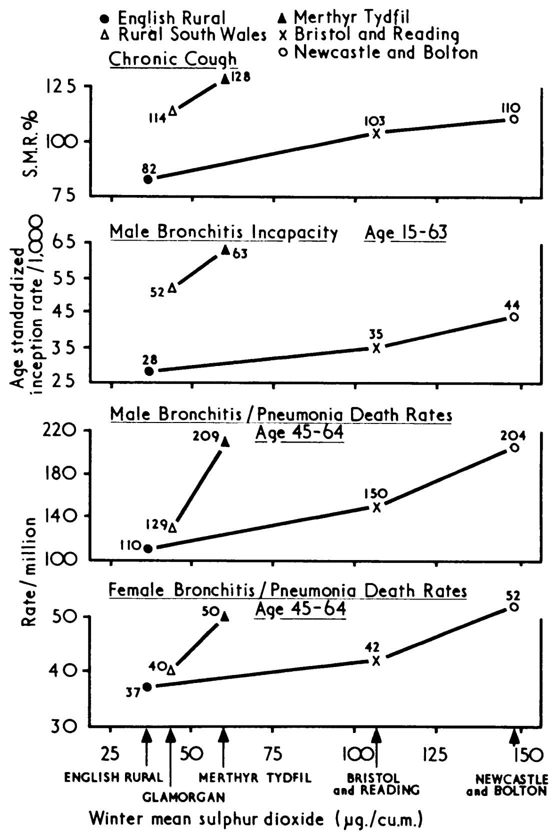

Fig. 2.—Indices of respiratory disease and air pollution.

consistent relationship between air pollution as measured by sulphur dioxide and each of the indices of respiratory disease for the areas concerned. In Wales there is an excess in all these indices in Merthyr Tydfil over those for rural Glamorgan. But the Welsh values are, for all indices of mortality and morbidity, higher than might be expected on the basis of the relationship between pollution and disease seen in the English data.

Discussion

This large survey of chronic respiratory disease in children has confirmed earlier reports of a social class gradient in this disease among children (Douglas and Bloomfield, 1958; Douglas and Waller, 1966; Colley and Holland, 1967; Lunn *et al.*, 1967). Of special import is the fact that this gradient, which is so pronounced a feature of bronchitis mortality in adults, appears in children even before they have begun to smoke. Nor is this social difference disappearing, for it is as clear now as it was in Douglas and Bloomfield's study of 15 years before.

Between children of the same social class there are pronounced geographic differences in their prevalence of chest disease within England and Wales. In England there is a general increase in symptoms with increasing levels of local air pollution, but the association is most clearly seen among the children of semi-skilled and unskilled workers. It seems unlikely that these geographic differences found within the same social class can be due to variation in domestic circumstances. After adjusting for the different numbers of children in each social class in each area, there was no geographic variation in the average numbers of persons per room, persons per dwelling, or rooms per dwelling large enough to explain these gradients.

Social class gradients similar to those seen in chest disease appear in the data on upper respiratory tract conditions. There is, however, no consistent gradient in the prevalence of diseases of the nose and ear with increasing levels of air pollution. In this the results of this survey agree more closely with those of Douglas and Waller (1966) than with those of Wahdan (1963) and Lunn *et al.* (1967).

In South Wales the rates for respiratory disease found in children are, like the rates for respiratory morbidity and death among adults, well above those in English areas with comparable levels of air pollution. These uniform excesses in young and old may have a common origin. High rates of absence from work or death due to bronchitis in men could be attributed to arduous or dusty work in the coal mines as well as to smoking. But the excess morbidity in young children, which on the results of the tests of ventilatory function is unlikely to result from overreporting, cannot be thus explained. Nor is it due to differences in social class structure for a Welsh excess in respirator morbidity appears in almost every social class. Other possible explanations are a specific ethnic susceptibility or long-continued emigration of the healthier families. Without further detailed studies the true reason will remain obscured.

Conclusion

The death rates from respiratory diseases including bronchitis, influenza, and pneumonia among children between the ages of 0 and 14 are twice as high in England and Wales as they are in the Netherlands and Scandinavia (Reid, 1969). There is thus as little room for complacency about respiratory disease in the young as in those in middle and late life where the national record is unenviable. These studies in children have brought out that though smoking and dusty work may be dominant factors in adult bronchitis, other general features of the locality such as air pollution may determine the onset or evolution of the disease in both young and old. As Holland *et al.* (1969) emphasized, much remains to be done to identify those characteristics of early environment or genetic endowment which increase susceptibility to respiratory disease. This study underlines the special urgency of the problem in South Wales and in England among the working-class families, particularly in the larger industrial cities of the North.

We are especially indebted to Dr. P. Henderson and Dr. E. E. Simpson, Department of Education and Science, and to the members of the school health service in the areas surveyed. The following medical officers took part: Dr. J. V. Bond, Dr. K. S. Cliff, Dr. I. J. Cope, Dr. W. H. Crichton, Dr. A. R. Davis, Dr. J. M. St. V. Dawkins, Dr. J. Deegan, Dr. W. R. Falconer, Dr. J. A. C. Franklin, M.O.H., Dr. T. McL. Galloway, M.O.H., Dr. A. Gatherer, M.O.H., Dr. S. C. Gawne, M.O.H., Dr. M. J. Gibson, Dr. C. A., Gunn, Dr. M. Harrison, Dr. N. M. Johns, Dr. J. D. Kershaw, M.O.H., Dr. B. E. Lovely, Dr. J. E. McKim-Thomas, Dr. W. J. McQuillan, Dr. E. A. Marsden, Dr. J. C. M. Mason, Dr. J. F. Mather, Dr. P. Morton, Dr. R. C. M. Pearson, M.O.H., Dr. M. E. A. C. Pickering, Dr. N. T. W. Pover, Dr. J. J. A. Reid, M.O.H., Dr. G. A. G. Robinson, Dr. M. G. H. Rogers, Dr. A. I. Ross, M.O.H., Dr. H. S. K. Sainsbury, Dr. J. M. Shobbrook, Dr. A. L. Smallwood, Dr. J. H. Stubbins, Dr. D. A. Thomas, Dr. J. L. Thomas, Dr. W. E. Thomas, M.O.H., Dr. J. B. Tilley, M.O.H., Dr. L. R. Vaughan Jones, Dr. W. M. Waggott, Dr. J. E. Walsh, Dr. A. D. Wedderspoon, Dr. W. G. Westall, Dr. V. L. White, Dr. D. Wild, Dr. R. M. Williams, M.O.H., Professor R. C. Wofinden, M.O.H.

Dr. Michael Hills of this department gave statistical advice and Mrs. Barbara Hunt supervised the analysis of the data. We are also indebted to the education officers and their staff for administrative assistance, but we are particularly grateful to the parents and children who gave us their help.

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