Original articles

Trends and district variations in the hospital care of childhood asthma: results of a regional study 1970–85

H R Anderson

Abstract

Trends and district variations in the prehospital and hospital care of children aged 0–14 years admitted with acute asthma were surveyed in all 13 districts of a health region by examining case notes for 1970, 1978, and 1985. From 1970 to 1985 there was a substantial increase in admissions and some reduction of hospital stay. Over this time adrenergic drugs remained the most frequently used treatment with a large shift towards selective beta$_2$ agonists administered by nebulisation. Use of corticosteroids fell in the under 5s with a decrease in the parenteral route of administration but rose in the 5–14 age group with an increase in the oral route of administration. There was an increase the use of oral xanthines but this was outweighed by falls in the use of suppositories and in parenteral administration. The use of antibiotics became less frequent and that of sedatives and antihistamines fell to almost nil. There were also important changes in other aspects of management, notably an increase in the use of lung function tests (from 3% to 70%) and falls in the use of chest radiographs, blood tests, bacteriology, and physiotherapy. In nearly all aspects of management there were significant and often very extreme variations in practice between districts, which were unlikely to be explained by differences in morbidity. These variations would be a suitable focus for medical audit, with the aim of establishing which treatment regimens have the best outcome and avoiding unnecessary cost and discomfort. Because early hospital drug treatment is closely related to the type of treatment given before admission such audit activities would need to include general practitioners.

Department of Public Health Sciences, St George's Hospital Medical School, London
H R Anderson

Address for reprint requests: Professor HR Anderson, St George's Hospital Medical School, London SW17 0RE.

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Over recent years there have been major changes in hospital statistics for childhood asthma.[1] These have been most pronounced among the 0–4 age group, which over the 16 years up to 1985 experienced an increase in admission rate from 10·9 to 75·6/10 000 and a decrease in mean length of stay from 6·1 to 2·4 days. In this age group the proportion of admissions to paediatric wards due to asthma increased from 2·9% to 9·4% and the proportion of bed days accounted for by asthma increased from 2·3% to 6·2%. Among the 5–14 age group admissions for asthma increased from 8·6 to 28·0/10 000, the mean duration of stay decreased from 9·4 to 3·7 days, the proportion of admissions to paediatric wards due to asthma increased from 10·9% to 19·3%, and the proportion of bed days increased from 10·6% to 15·8%. The increase in asthma admissions has been attributed mainly to an increasing preference on the part of families and their general practitioners for acute asthma to be treated in hospital,[2 3] made possible in part by increased availability of beds,[4] though there is also the possibility that morbidity has increased.[5 6] The decrease in length of stay could be explained by more effective treatment in hospital, lesser severity at admission, or greater severity at discharge but there is little evidence on this subject. Concern has also been expressed that some aspects of current treatment may have an adverse effect on longer term prognosis.[7 8] Mortality from childhood asthma has, if anything, fallen over recent years,[9] though there may have been an increase among young adults.[10]

Over the last 20 years there have been many developments and refinements in drug treatment for asthma[11] and there has been a corresponding fall in the use of non-drug treatments.[12] Currently available prescription data are limited by not being diagnosis or age specific and they do not include what is prescribed in hospitals. Analysis of prescriptions, however, leaves little doubt that general practitioners have, on average, responded rapidly to these developments.[13]

A previous study conducted by this department described trends in the clinical characteristics and early hospital management of children aged 5–14 admitted to hospitals in the South West Thames Region with acute asthma from 1970 to 1978.[2] The present study extended the data for the 5–14 age-group to 1985 and in view of the substantial increase in admissions among the 0–4 age group obtained data on these for 1978 and 1985. The primary objective of the study was to investigate trends in severity, mode of referral, and readmissions and this aspect has been reported.[6] It also presents an unusual opportunity to

document for an entire health region (population three million) trends in the management of acute childhood asthma before and after admission over a 16 year period, and to examine variations in medical care between districts. The Government's recent proposals for developing formal medical audit in the National Health Service[14] will require more information about current practice[15] and the data presented here provide insight into what might be achieved by a regional approach.

Methods

The sampling method and protocols followed those used in the previous study[2] but will be described briefly here. One hospital from the previous study was excluded because it now lay outside the regional boundaries as a result of reorganisation in 1981. A list of all children under 15 years admitted with a first diagnosis of asthma (ICD 493) was obtained from Hospital Activity Analysis records for 1978 and 1985. For practical reasons no attempt was made to obtain data for 1970 for the 0–4 age group. Approval was obtained from the ethical committees of all 13 health districts within the region and the consultants responsible gave written permission for the case notes to be examined by a research assistant.

The target sample was 600, comprising 200 each for the 0–4 age group in 1978 and 1985 and the 5–14 age group in 1985; the numbers finally examined were 190, 207, and 202. For the 5–14 age group, data from 1970 (n = 178) and 1978 (n = 210) were available from the previous study. For each hospital, by each year and age group, all individuals with an immediate admission for asthma were numbered. Where there was more than one admission for an individual, one admission was selected randomly. The sampling fractions were 56% for the 1978 0–4 age group, 21% for the 1985 0–4 age group, and 26% for the 1985 5–14 age group. Using these sampling fractions we calculated target samples for each group for each of the 16 hospitals. Within each hospital the study serial number of each patient was permutated and the notes were examined in that order. This enabled the target sample to be obtained despite some missing notes (23% of notes looked for).

Data extracted from the notes included mode of referral, duration of episode, vital signs (pulse and respiration rates) on admission, treatment in the 24 hours before and after admission, and results of investigations. From the Hospital Activity Analysis listing, readmissions within the calendar year of the index admission were recorded. Categorical data were examined by means of the χ^2 test or the difference between two proportions. Heterogeneity between districts was examined with the χ^2 test or one way analysis of variance as appropriate.

Table 1 Treatment in the 24 hours before admission

Drug	0–4 years (%)		5–14 years (%)		
	1978 (n=190)	1985 (n=207)	1970 (n=178)	1978 (n=210)	1985 (n=202)
At least one adrenergic drug	62	69	72	82	80
Beta$_2$ adrenergic:					
Any route	54	68*	7	77	80†
Oral	43	47	3	57	21*†
Inhaled *not* nebulised	5	8	} 4	} 23	51*†
Nebulised	0	19*			21
Parenteral	0·5	0	0	4	0*
Beta adrenergic (not beta$_2$ selective):					
Any route	8	2*	38	7	0·5*†
Oral	7	2*	26	5	0·5*†
Inhaled	0	0	7	1	
Ephedrine (with or without other drugs)	0·5	0	40	5	0·5*†
Adrenaline, subcutaneous	3	0*	15	5	0*†
Xanthine:					
Any route	18	18	27	25	25
Oral	7	17*	6	11	19*†
Parenteral	2	0*	4	6	1*
Suppository	9	0·5*	19	8	1*†
Corticosteroids:					
Any route	11	7	13	31	14*
Oral	7	4	8	11	4*
Parenteral	3	1	7	5	2†
Inhaled	2	4	N/A	21	8*
Anticholinergics, inhaled	0·5	2	0	1	2†
Sodium cromoglycate	5	4	33	47	23*
Antibiotic	33	26	51	40	18*†
Sedative	0·5	0	7	2	0*†
Antihistamine	11	5*	25	23	4*†

*1978–85 $p < 0.05$; †1970–85 $p < 0.05$.

Results

0–4 YEAR AGE GROUP 1978–85

The proportion of 0–4 year old children admitted with asthma who were referred by a general practitioner fell slightly, from 66% to 61%. There was no change in the readmission ratio (1·5 in each year), and the mean length of stay fell only slightly, from 2·7 to 2·6 days.

Treatment before admission (table 1)

In 1985 adrenergic drugs were used before admission by 69% of those admitted. This was a slight increase from 1978 (62%) but more notable was the substantial increase in the use of nebuliser treatment from zero to 19%. Oral administration remained the commonest single route, at around 45%. By 1985 selective beta$_2$ (adrenoreceptor) agonists had all but completely replaced the earlier, less selective beta$_2$ agonist (orciprenaline), the non-selective beta agonist (isoprenaline), and the earliest adrenergic drugs (ephedrine and adrenaline), which have both alpha and beta agonist actions. In both years 18% of children had been treated with a xanthine drug but, whereas in 1978 suppositories had been the most common form of administration, by 1985 the oral route was almost universally preferred.Corticosteroids had been given in about 10% of cases by various routes and there was no obvious trend in the route chosen. The other notable changes were a fall in the use of antibiotics (33% to 26%) and of antihistamines (11% to 5%).

Table 2 Drug treatment on admission and over the first 24 hours

Drug	0–4 years (%)		5–14 years (%)		
	1978 (n=190)	*1985 (n=207)*	*1970 (n=178)*	*1978 (n=210)*	*1985 (n=202)*
At least one adrenergic drug	89	92	88	98	97†
$Beta_2$ adrenergic:					
Any route	89	92*	4	97	98†
Oral	57	32*	3	53	10*†
Inhaled *not* nebulised	10	6	2	20	36*†
Nebulised	53	85*		64	88*†
Parenteral	5	0*	0	4	2
Beta adrenergic (not $beta_2$ selective):					
Any route	0·5	0	66	2	1†
Oral	0	0	63	1	0†
Inhaled	0	0	1	0·5	
Ephedrine (with or without other drugs)	2	0	24	1	0†
Adrenaline, subcutaneous	2	0*	8	1	0†
Xanthine:					
Any route	53	35*	67	54	35*†
Oral	19	27*	6	23	23†
Parenteral	32	8*	24	28	13*†
Suppository	14	1*	53	13	1*†
Corticosteroids:					
Any route	44	33*	21	47	46†
Oral	25	26	13	30	35†
Parenteral	30	11*	16	22	15
Inhaled	1	3	0	16	10†
Anticholinergics, inhaled	0·5	24*	0	0	23*†
Sodium cromoglycate	5	5	24	35	23*
Antibiotic	50	26*	61	40	13*†
Sedative	6	0·5*	20	1	0†
Antihistamine	14	1*	58	12	3*†

*1978–85 $p < 0·05$; †1970–85 $p < 0·05$.

Treatment in hospital over the first 24 hours (table 2)

There was little change in the use of adrenergic drugs between 1978 and 1985 (89% and 92%), but there was a substantial reduction in the use of the oral route and an increase in the use of nebulisers (53% to 85%). Use of anticholinergic drugs by inhalation increased from 0% to 23%. The use of xanthines fell from 53% to 35% but despite this there was an increase in the number of children treated with oral xanthines accompanied by a substantial fall in the use of parenteral and rectal routes for administration. Treatment with corticosteroids fell a little, from 44% to 33%; but, whereas oral treatment did not change, parenteral treatment fell by two thirds. There were substantial falls in the use of antibiotics, sedatives, and antihistamines. Non-drug items of management are shown in table 3. An intravenous drip was used much less in 1985, corresponding to the falls in the use of parenteral xanthines and corticosteroids mentioned above. The other notable change was a fall from 34% to 19% in the use of physiotherapy. Assisted ventilation was infrequent (0·5%) in both periods.

The most commonly ordered investigations were chest radiography, full blood count, respiratory bacteriology, and microscopy and culture of midstream urine specimens. All became less frequent during the eight years. Arterial blood gases were rarely analysed. As might be expected in the under fives, lung function tests were rarely performed.

Table 3 Non-drug management and investigations on admission and over the first 24 hours

Drug	0–4 years (%)		5–14 years (%)		
	1978 (n=190)	*1985 (n=207)*	*1970 (n=178)*	*1978 (n=210)*	*1985 (n=202)*
Drip	35	13*	4	20	17†
Oxygen	8	0·5*	21	13	3*†
Humidifier	16	1·5*	24	9	0*†
Assisted ventilation	0·5	0·5	1	1	0
Physiotherapy	34	19*	26	34	17*†
Blood gas analysis	2	0*	3	5	2
Chest radiograph	71	56*	80	61	51*†
Haemoglobin measurement or full blood count	58	23*	75	58	20*†
Bacteriology (throat/sputum)	73	48*	79	71	40 *†
Midstream urine	63	40	35	40	29*
Lung function tests:					
At any time during stay	5	8	12	57	72*
On date of admission	4	7	3	34	70*†

*1978–85 $p < 0·05$; †1970–85 $p < 0·05$.

5–14 YEAR AGE GROUP 1970–85

In the years 1970, 1978, and 1985 the proportion of 5–14 year old children admitted with asthma who had been referred by a general practitioner fell from 70% to 48% to 45%, and the readmission ratio increased from 1·22 to 1·42 and then fell back to 1·26. The average length of stay fell from 6·2 to 3·4 to 2·6 days.

Treatment before admission (table 1)

The use of adrenergic drugs before admission changed little (from 72% to 80%) but there was a pronounced shift towards inhaled and away from oral methods of administration of these drugs. The use of less selective beta agonists and of adrenaline and ephedrine fell away to virtually nil. In all three years about 25% of children had received xanthines before admission but there was a notable shift away from parenteral and rectal routes of administration towards the oral route. The use of corticosteroids did not show a consistent trend, increasing from 13% to 31% between 1970 and 1978 and then falling back to 14% in 1985. Parenteral steroids fell from 7% to 2%. Inhaled steroids (introduced in 1973) fell from 21% to 8% between 1978 and 1985. Between 1978 and 1985 there was a significant fall in the number of children receiving cromoglycate but there was no significant change over the longer term, 1970 to 1985. The use of antibiotics fell from 51% to 18% and the use of sedatives and antihistamines fell to virtually nil.

Treatment in hospital over first 24 hours (table 2)

In 1970 nearly 90% of the children admitted received adrenergic drugs and by 1978 this had risen to nearly 100%. Within this group there was a large fall in use of the oral route and a corresponding rise in use of the inhaled route. Between 1978 and 1985 use of nebulisers increased from 64% to 88%. The use of xanthines fell from 67% to 35%, the increase in

the proportions treated orally outweighed by falls in the use of suppositories (from 53% to 1%) and of the parenteral route (from 24% to 13%). The use of corticosteroids more than doubled from 1970 to 1978 but did not change thereafter. There were substantial falls in the use of antibiotics, sedatives, and antihistamines. Non-drug aspects of management are shown in table 3. The use of an intravenous drip increased up to 20% in 1978 and changed little thereafter. There was no change in the very low proportion receiving assisted ventilation. Physiotherapy did not show a consistent trend but was lowest in 1985.

Measurement of lung function on the day of admission increased from 3% to 70% but there was no significant change in recorded blood gas measurements. In 1985 the most frequently recorded investigations after lung function tests were chest radiography (51%), respiratory bacteriology (40%), microscopy and culture of midstream urine (29%), and measurement of haemoglobin or full blood examination (20%). With the exception of urine microscopy and culture, all of these tests were ordered less frequently in 1985 than in 1970.

FACTORS ASSOCIATED WITH HOSPITAL MANAGEMENT IN 1985

It was predicted that early hospital management would be related to the age of the patient, clinical severity at admission, and treatment for the episode before admission. Within each age group mode of referral, duration of symptoms, readmission history, and pulse rate at admission were not generally related to the type of drug treatment given in hospital or to whether a lung function test or chest radiography was done. No other measures of clinical severity were sufficiently well recorded to analyse this aspect further. In contrast, the type of drug treatment received before admission was an important determinant of early hospital treatment. The chance that corticosteroids, xanthines, cromoglycate, and antibiotics would be given in hospital was significantly increased in each case if these drugs had been used before admission. Among the 0–4 age group the relative risk (95% confidence limits) was 6·4 (CL 1·9, 21·4) for steroids, 6·8 (3·1. 14·7) for xanthines, 9·6 (1·6, 57·3) for cromoglycate, and 3·8 (1·7, 6·4) for antibiotics. The corresponding relative risks for the 5–14 age group were: steroids 3·3 (1·4, 7·6), xanthines 5·7 (2·9, 11·4), cromoglycate 10·3 (4·8, 22·0), and antibiotics 8·27 (3·4, 19·9).

VARIABILITY ACROSS DISTRICTS WITHIN THE REGION IN 1985

For this analysis the two age groups were combined to form a sample of 409 children aged 0–14 years. The sample number for each health district ranged from 12 to 88 (median 27). There was no significant variation in age, pulse or respiration rates at admission, temperature, or prior respiratory infection. There were, however, wide variations in self referral (range 14–63%; $p < 0.000$), median length of stay (range 1–3·5 days; $p < 0.000$), readmission in same year (range 4–44%; $p < 0.01$), and proportion of episodes that had lasted under 18 hours (range 27–92%, $p < 0.01$).

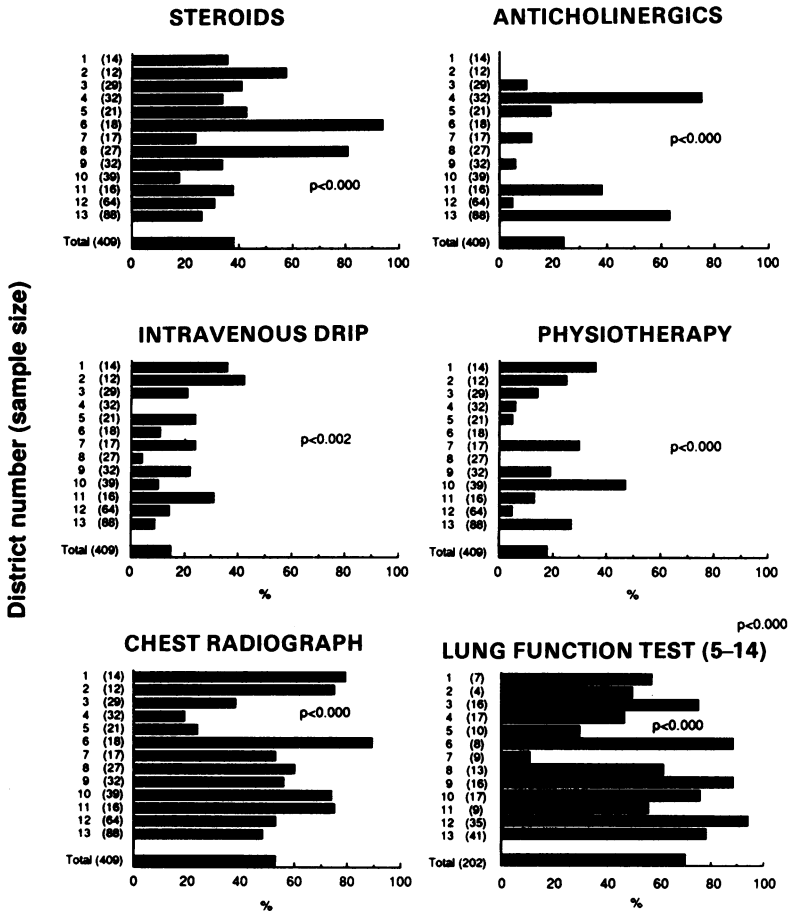
Table 4 summarises the district variations in drug treatment and other aspects of management. With the exception of $beta_2$ adrenergics given by nebuliser (which were commonly used in all districts) and antibiotics, there were large variations in all aspects of management recorded and, despite the small samples from some districts, tests of heterogeneity gave highly significant results. For example, the use of corticosteroids ranged from 18% to 94%, of xanthines from 11% to 75%, and of anticholinergics from zero to 75%. The variability from district to district in selected treatments and investigations is illustrated in the figure.

Table 4 Variations in the management of acute asthma in children aged 0–14 years admitted to 13 hospitals in the South West Thames Region in 1985

Management	*% of children (mean (range) for region)*	χ^2 *(df = 12)*	*p*
Beta adrenergics by nebuliser	86 (76–100)	13	NS
Anticholinergics	24 (0– 75)	176	<0·000
Xanthines	35 (11– 72)	46	<0·000
Steroids	38 (18– 94)	64	<0·000
Adrenergics + xanthines + steroids	36 (18– 94)	13	NS
Cromoglycate	14 (0– 38)	25	<0·02
Antibiotics	19 (6– 33)	15	NS
Intravenous drip	15 (0– 42)	31	<0·002
Physiotherapy	18 (0– 47)	55	<0·000
Lung function test (5–14 years only)	70 (11– 94)	45	<0·000
Chest radiograph	53 (19– 89)	52	<0·000
Bacteriology (respiratory)	44 (4– 86)	132	<0·000
Urine microbiology and culture	35 (6– 67)	93	<0·000
Haemoglobin measurement or full blood examination	22 (4– 59)	46	<0·000

Discussion

This study describes, for an entire health region of three million people, trends in the management of acute childhood asthma during a period in which there has been an increase in admissions, a decrease in length of stay, and no major change in mortality. Existing sources of population based data on drug treatment are not diagnosis or age specific and do not provide information about what is prescribed in hospitals. Other studies in United Kingdom hospitals that have examined the care of childhood asthma in hospital, though often more detailed than the present study, have been confined to single hospitals or districts,[3 16] have included the whole age range,[17–19] or have been confined to adults.[20] Other studies have concentrated on accident and emergency assessment and treatment.[17 19] The study of Storr *et al*[3] is the only one that examined trends but it was confined to one specialist children's hospital. The strength of the present study lies in its size, use of consistent methods over time, and regional scope. Although it was not the original aim of the project, it has been possible to provide for the first time a description of district variations in care and carry out some crude analyses of these. Hospital records have serious limitations as a source of clinical data but the records of drugs and tests are unlikely to have been underestimated as these require signature in



District variations in the percentage of children aged 0–14 years admitted to hospital with asthma who received selected items of management.

most instances. Exceptions include oxygen and ward procedures such as lung function monitoring, where there is, strangely, no clinical, legal, or administrative requirement to make a record.

Can the results shed any further light on the reasons for the increase in admissions? Patient simulation exercises and questionnaires have shown that doctors vary widely in the ways in which they approach the management of asthma[21–23] and preferences and habits of treatment are likely to change over time. Thus trends in the intensity of treatment provide only a rough guide to trends in the severity of the condition. Nevertheless, in so far as intensity of treatment can be taken to reflect severity, our results support the proposition that there has been no major shift in the range of severity in the children admitted to hospital.[6] There was little change between 1970 and 1985 in the proportions treated with adrenergic drugs, xanthines, or corticosteroids before admission. Similarly, there was no evidence that the level of treatment at admission had diminished in intensity. This corresponds to the previously reported finding from this study that there has been little or no change in the severity of asthma at admission to hospital as measured by vital signs and duration of symptoms before admission.[6] It therefore appears that an increasing number of children are being treated with an intensity at least as great as that of former years.

The fall in length of stay (5–14 age group only) might be explained by a trend towards a milder clinical condition at admission, more severe asthma at discharge, or more effective treatment. As mentioned above, there is some evidence—albeit not overwhelming—that the severity of asthma at admission has not changed. There is no evidence concerning the severity of asthma at discharge but it is relevant that there has been no increase in readmission rates over the years, suggesting that children are no less fit for discharge than formerly and that aftercare is no less adequate. The most attractive explanation for the fall in length of stay is that it is the result of more effective treatment but there is little evidence from trials throwing light on this question.

The trend towards the use of more selective $beta_2$ adrenoreceptor drugs given by inhalation and away from sedatives and antihistamines probably reflects changes in recommended practice. Similarly, antibiotics were previously advocated for acute asthma[24] and their decline in use probably reflects the failure of well conducted trials to establish their value as a routine treatment.[25 26] On the other hand, despite recommendations that acute severe asthma should be treated with corticosteroids,[27] the proportions treated with steroids did not increase, remaining at under half. Assessment of acute asthma with a lung function test and subsequent monitoring is regarded as essential,[28] and in one study it was the only clinical measurement that distinguished those who would respond to beta agonists from those who required more intensive treatment.[29] Although the proportions assessed by this test increased substantially the level had reached only 70% in 1985 among children aged 5–14 years admitted to hospital. Use of oxygen is an important aspect of treatment[28] but despite this there was a fall in the recorded use of oxygen. This is difficult to interpret because it is not "prescribed" as a drug. Another study of the hospital care of acute asthma also found that oxygen therapy is often not recorded.[17] There has also been a fall in the use of physiotherapy, which may reflect some of the doubts about its use in acute chest conditions.[30] The fall in the use of chest radiography corresponds to an increasing awareness that its use in childhood asthma should be selective[31 32]; the current level of use (over 50%) should be questioned.

When we are considering the reasons for the high use of possibly inappropriate treatment such as antibiotics, or of investigations such as chest radiography, it is important to recognise that these cases were selected on the basis of a discharge diagnosis of asthma. The child may have been admitted with a different diagnosis, for which such management was entirely appropriate, and it was only as the illness evolved and investigations were performed that the diagnosis of asthma was made. Future studies will need to take account of this.

The study provides, in part, a basis for auditing the process of care for acute asthma in children at a regional level. This is particularly timely in view of the recent government review of the National Health Service,[33] in which one of the major proposals is for systematic audit.[14]

The objectives and principles of medical audit have recently been described by a working party of the Royal College of Physicians.[15] Process review requires, among other things, that information is available about the process and that there is some agreed standard against which to make a judgment. Although there is no lack of advice from the medical press about treating acute asthma it is only very recently that experts have been able to agree consensus statements against which it might be possible to compare descriptions of practice.[34] Because pharmacological developments are so rapid, changes in practice are sometimes based on the theoretical superiority of one treatment over another or on small trials of efficacy. This survey shows how rapidly practice can change both at the hospital and the general practice level and this in itself testifies to the readiness of doctors to change—an essential precondition if high quality care is to be assured.

At an international level there exist enormous variations in the drug treatment of acute asthma.[35] Within Europe, for example, there is a preference in the United Kingdom for inhaled drugs, whereas elsewhere there is a preference for xanthines. In a recent review from the United States the recommended adrenergic drugs for acute childhood asthma were adrenaline and isoprenaline,[36] both of which have disappeared from use in South West Thames and, presumably, the United Kingdom.

The present study shows that there are also very great variations in practice between districts (generally served by one hospital) within the South West Thames Region. These variations were generally highly significant statistically despite some small district samples and they are most unlikely to be explicable by clinical differences between asthmatic patients in different districts. There was evidence that some of the variation in hospital treatment reflected the prehospital treatment. This provides a reasonable explanation for the use of cromoglycate in hospital, which at first sight appears inappropriate in acute asthma. Any process review of hospital treatment will therefore need to take account of the treatment in the community, and in the case of asthma implementation of change as a result of audit will require the development of agreed policies with referring general practitioners. Other elements of the variation will reflect individual factors such as paradoxical responses to treatment (see, for example, O'Callaghan *et al*[37]) or previous treatment failure. Probably, however, some of the variation can be explained only by the prevailing custom in the hospital concerned. Do these variations matter in terms of outcome or of cost?[35] If the outcome is the same, the cheapest and least uncomfortable treatment regimens should be used. Several trials have compared different drugs for acute asthma and different routes of administration of drugs, but more trials will be needed. To be applicable in the district setting these trials will also need to take into account the role of the general practitioner in the treatment of acute asthma.

It must be emphasised that this study was not designed as an audit, nor was it designed to analyse district variations. A planned audit would have required adequate district sample sizes, more data on clinical severity (including lung function), more details of drug treatment, and better indicators of outcome. Furthermore, the data are relatively old (1985). Nevertheless, the results provide a glimpse of what might be gained by a regional approach to audit. Were this to be attempted the participating clinicians not only would have to agree what data were required but also would have to ensure that they were recorded in an analysable form. An agreed structured clinical recording form would facilitate this and once in use would provide an information system capable of examining the kinds of questions likely to be thrown up by the audit.

Current developments in medical audit are tending to emphasise the role of activities within districts. The present study indicates that a regional approach to the audit of asthma care, with the focus on the hospital and district rather than on individual patients and doctors, has some attractions.

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