Screening for asthma in children

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SUMMARY

The primary health care team is at the forefront of asthma management and there is evidence of improved delivery of care via nurse run, audited, general practice clinics. However, hospital admissions for asthma continue to rise. Screening for childhood asthma would appear to have advantages for patient care. This review looks critically at the literature that addresses important issues in screening for childhood asthma, including the problem of defining asthma, its prevalence rate and the importance of dealing with asthma as part of a spectrum of illnesses of the upper respiratory tract. The fundamental principles of screening in relation to asthma are addressed, and five screening procedures are described and debated. Questionnaire studies are concluded to be relatively cheap and reliable, and a compilation of validated questions is described. Such questions could be tailored to individual practice needs and used in the early detection of asthma, giving the potential for early intervention and improved quality of life.

Keywords: asthma; screening; screening effectiveness; children and infants.

Introduction

THE primary care team is at the forefront of the management of asthma in children. This is reflected in the increase in support given to general practitioners for example by the British Thoracic Society and the National Asthma Campaign.

It has been estimated that 97% of all cases of asthma are treated at primary care level.[1] Fortunately, even though there is evidence of increased hospital admissions,[2] few children die from the condition: approximately 40 children die each year in the United Kingdom.[3] The increase in hospital admissions is probably due to an increase in the number of asthmatic children experiencing severe asthma attacks[2] and, as yet, there is no objective evidence of the extent to which children with previously undiagnosed asthma are being admitted to hospital. The debate as to whether the prevalence of asthma is increasing continues, but most evidence seems to suggest an increase.[4-10]

Interest in setting up nurse run asthma clinics[11,12] has resulted in more comprehensive programmes of asthma care, and several audits have highlighted the need for early diagnosis and appropriate treatment plans.[13-17] Nevertheless, in one study published in 1986 informational, educational programmes were found to be ineffective in reducing asthma morbidity when applied to a general practice population.[18]

The possibility of devising a screening programme for childhood asthma in the community has theoretical advantages for patients. This review looks critically at the literature which addresses important issues in screening for asthma in childhood in the community.

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Submitted: 18 December 1992; accepted: 6 May 1993.

© *British Journal of General Practice*, 1994, **44**, 179-183.

Definitions of asthma

There is no gold standard for defining asthma. Aretaeus (81–131 AD) first advanced a definition of asthma by suggesting that it was a disease and not a symptom.[19] It was not until the 17th century that Schneider and Lower proved the anatomical impossibility of the ancient Greek concept of catarrh descending from the brain through the cribriform plate via the nasal cavities to the lungs.[20,21] The influential work of Floyer, Willis, Cullen and Salter in the 17th, 18th and 19th centuries gave insight into the spasmodic nature of the disease, and identified common precipitating factors.[22-25]

In 1943, Rackemann and Edwards introduced the term extrinsic asthma to imply clinical sensitiveness to certain foreign substances; they believed intrinsic asthma to be caused by factors of a non-allergic nature such as infection and maladaptation to physical or psychic trauma.[26]

In 1959, the Ciba Foundation guest symposium suggested that asthma might be defined in terms of a disorder of function, as a 'disease characterized by variable dyspnoea due to a widespread narrowing of peripheral airways in the lungs varying in severity over short periods of time either spontaneously or as a result of the treatment'.[27] The American Thoracic Society arrived at a similar definition but added the important observation that the bronchi also showed increased responsiveness.[28] Scadding suggested that '...asthma is a disease characterized by wide variation over short periods of time in resistance to flow in intra-pulmonary airways...'[29] However, this definition was limited by the omission of a clinical picture.

A patient with a cough, a common symptom of asthma,[30,31] may be regarded as having acute bronchitis rather than asthma. A consequence is the underdiagnosis of asthma[32,33] and consequent underestimation of asthma attack and prevalence rates. An editorial defining asthma pointed out '...however much variable airways resistance as a start satisfies some of us, there are a large number and variety of phenomenon which others feel to be the peculiarity "asthma" should signify'.[34]

The physiologist would define asthma in terms of hyperactive airways, the pathophysiologist in terms of inflammation, mucosal swelling and smooth muscle hypertrophy, and the clinician in terms of wheezy dyspnoea. It can be seen that although it is generally agreed that asthma is a condition in which there is reversible airways obstruction, it remains impossible to reach universal consensus on a precise definition.

Although there is no gold standard for defining asthma in childhood, the definition used by an international paediatric asthma consensus group gives a useful start: 'a condition in which episodic wheeze and/or cough occurred in a clinical setting where asthma was likely and other, rarer conditions had been excluded'.[35]

Prevalence of asthma

It is perhaps not surprising that in a disease that has defied any accurate definition, there are inherent difficulties in accurately determining its prevalence. Estimates of the prevalence of asthma in children up to 15 years of age vary from 5%[36] to 31%.[37] Some rates refer to the prevalence of wheeze and thus are usually higher than those for asthma.[38-40]

Usherwood reviewed a number of publications providing data on the prevalence of asthma and wheezing in children in the UK.[41] The number of cases of asthma and wheezing that are found in a sample depends on the diagnostic criteria employed in the study. Such problems in measurement have been encountered by Hart,[42] Gregg[43] and Gellert and colleagues.[15]

Gregg gives an account of some of the epidemiological aspects of asthma and a comprehensive review of the range of prevalence recorded in European, American, African and southern Pacific populations.[44] Asthma was virtually unknown in Papua New Guinea but had a prevalence of 45% on the island of Tristan da Cunha, a highly inbred and relatively isolated community. Interestingly, Smith and colleagues found that the prevalence of asthma in Asian and West Indian children who had been born in their home countries was much lower than that of British children whereas the prevalence of asthma in Asian and West Indian children who had been born in the UK was similar to that of British children.[45] It has been inferred from this and similar studies that an environmental factor accounts for this increasing prevalence in immigrant children in the UK.

Whatever the epidemiological arguments that define asthma diagnosis and prevalence, it is likely that the increased prevalence of wheeze and respiratory symptoms noted in longitudinal studies[8,46-48] could not reflect anything other than a true increase in asthma. This increase may be linked to an apparent increase in atopy in general.[5,49]

Asthma as part of a spectrum

Wide-ranging studies have been carried out to define asthma in terms of abnormal airways lability. This bronchial hyperreactivity can be investigated using a number of different challenges including exercise, inhaled cold air, or inhalation of bronchoconstrictor substances such as histamine or methacholine. Using these techniques children can be grouped according to their responses. Studies on airways lability support the concept that although there may be genetic influences, asthma represents one end of a continuous spectrum[50] rather than a specific defect.

In an extensive study of over 2000 children in New Zealand bronchial hyperreactivity was shown to be unimodally distributed, with those in whom asthma had been diagnosed dominating the severe end of the spectrum.[51] Similarly, work in Canada showed that bronchial hyperresponsiveness was unimodal in distribution, the asthmatic subjects representing a subgroup within the hyperresponsive distribution tail rather than a separate distribution peak.[52]

Other workers have also commented on asthma as a syndrome, with widely varying clinical manifestations and severity.[53] Others have described a bronchial irritability syndrome and have shown a close relationship between this syndrome and bronchial hyperreactivity.[54-56]

If, as seems likely, asthma is part of a spectrum of illnesses, what other illnesses are in this spectrum? Little is known about the relationship between wheezing in infants and asthma in later life, even though the spectrum of wheezing and catarrhal illnesses in childhood were accurately recorded as long ago as 1961.[57] Data from the national child development study show that being a boy or having had pneumonia, whooping cough, tonsillectomy, adenoidectomy, allergic rhinitis and eczema are predictive of asthma, with whooping cough, throat or ear infections, discharging ears, tonsillectomy and adenoidectomy being concurrently associated.[58] Bronchitis, croup and whooping cough increase the likelihood of developing asthma later in life, particularly if the child is atopic.[59,60] The relationship of illnesses within this spectrum needs closer examination and primary care is well placed for this.

Screening for asthma

The general principles of screening any population for overt or undetected disease were described by Wilson in 1968.[61] These can be summarized, with reference to asthma in children, as follows:

- The condition should be an important health problem: 12% of children suffer from asthma.[33]
- There should be accepted treatment: there are now clear guidelines on asthma management, drawn up by consensus.[35]
- Facilities for diagnosis and treatment should be available: current data suggest that asthma is still underdiagnosed and undertreated.[33,35]
- There should be a recognizable latent or early symptomatic stage: Levy and Bell showed that, on average, a child consulted the general practitioner 16 times before a diagnosis of asthma was made[13] while Jones and Sykes showed that the delay in diagnosis approximated to 40% of the age of the child at diagnosis.[16]
- There should be a suitable and acceptable test for examinations: as there is no gold standard for defining asthma, there is, as yet, no simple reliable test that can be used in a screening programme. However, several screening procedures can serve as a guide towards further clinical investigation.
- The natural history of the disease, from latent to overt disease, should be adequately understood: knowledge of the relationship between wheezy illnesses in infancy and childhood and clinically recognizable asthma is incomplete. A screening programme, even at one point in time, can help in the understanding of the relationship between asthma and other related illnesses.[62]
- There should be an agreed policy on whom to treat: where asthma is recognized, management guidelines can be applied. Even though there is increasing evidence that adult chronic obstructive airways disease begins in childhood[63-66] there are few longitudinal studies that prove that treating mild or moderate asthma aggressively in childhood confers long-term benefits.
- The cost of case-finding (including diagnosis and treatment) should be economically balanced in relation to possible expenditure in medical care as a whole: identifying most cases of asthma by simple non-invasive means such as a questionnaire or scrutiny of patients' notes is inexpensive and part of good clinical practice, with little or no relationship to overall expenditure.
- Case-finding should be a continuous process: this highlights the need for a safe, simple and repeatable test, even though lower sensitivity may have to be accepted for the sake of ease and practicality.

Questionnaires

As a screening instrument, questionnaires are non-invasive, inexpensive, safe, convenient and can be self-administered or completed by a parent. Studies using questionnaires to screen for asthma have been widely reported and do not depend on the time of year they are conducted or whether there is current infection.[15] The simple question 'have you ever had asthma?' is specific in that nearly all who have asthma will answer positively but it is insensitive in that many who do in fact have asthma are unaware of it.[67] Questionnaires rely on parents' or children's recall of symptoms and parents differ in the reporting of asthma symptoms, fathers being less likely to volunteer evidence of asthma than mothers.[68] It is also possible that feelings of stigma or pessimism may introduce recall bias.[69]

Lung function tests

Peak expiratory flow rates and forced expiratory volume in one second measurements are easy to perform, reproducible and show the diurnal variation characteristic of asthma. They also enable longer term assessment of the asthmatic child to be made by using diary cards. Comparisons can be made for diagnostic purposes between potentially asthmatic children and the patterns recorded for normal children.[70,71] They also provide a simple method of assessing therapy. However, even moderately severe asthma sufferers can have a normal peak expiratory flow rate between attacks and normal children exhibit a fall in peak expiratory flow rate following viral upper respiratory tract infection.[72]

Skin prick tests

Skin prick tests on patients with asthma can detect the presence of atopy: 80% of three year old asthmatic children and over 90% of 10 year old asthmatic children will have positive skin prick test results.[73] However, the relationship between positive skin tests and clinical symptoms is poor and skin tests are rarely useful in helping to make a diagnosis.[74] The popularity of skin prick testing suffered a setback with the decision of the Committee on Safety of Medicines to withdraw specific immunotherapy in 1988.[75]

Exercise tests

A clear association between asthma and exercise was recognized as early as 1679 and 1710.[22,23] Herxheimer was possibly the first to study the effect of exercise objectively by measuring the vital capacity of asthmatic subjects and recording the changes which occurred after running and cycling.[76] He concluded that the hyperventilation during exercise was responsible for the fall in vital capacity which followed exercise.

There has been controversy over whether exercise caused bronchodilation or bronchoconstriction.[77-79] It is now known that the results depend on whether observations are made during or after exercise and also on the type of exercise undertaken. The definitive work of Jones, Buston and Wharton showed the characteristic increase in airways obstruction in the asthmatic child which reaches its maximum level approximately three minutes after stopping running and which does not occur in the normal child.[80] A fall in peak expiratory flow rate of more than 15% is widely held to indicate exercise-induced asthma. Further work has shown running to be a more potent and reproducible stimulus for exercise-induced asthma than other forms of exercise;[81] also that the running needs to last about six minutes and be intense enough to raise the child's heart rate to about 170 beats per minute.[82] The highest of three peak expiratory flow rate measurements should be recorded before and after exercise.

Some 80–90% of asthmatic children will have an abnormal response to exercise.[83,84] The abnormal response is not affected by the clinical state of the child and can be elicited when either well or wheezy,[82,85] and may also be found some years after the child has stopped having symptoms.[86] Abnormal airways lability as measured by exercise tolerance is seen in non-asthmatic atopic children and in relatives of children with asthma.[87] Results of exercise tests carried out in the community, however, would seem to indicate that exercise is not quite as sensitive a test as the earlier work on more severe, hospitalized children suggested.[88]

In 1973 Burr and colleagues examined the effect of exercise on 817 children[89] and repeated the study 15 years later and found a real increase in asthma prevalence.[8] Similar work was carried out on school children in Sheffield[88] and the acronym FRAST for free running asthma screening test was introduced.

A total of 950 Welsh children aged 4–11 years underwent an exercise test and it was found that 60 children not known to have clinical asthma at the time had at least a 15% fall in peak expiratory flow rate after exercise.[90] Many of these children (32/55) went on to develop asthma over the next six years. Other upper respiratory tract illnesses were found to be more common in this asthma group than in the closely matched, non-asthmatic control group. The exercise test thus identified a pre-asthmatic or latent asthmatic group who had had more respiratory illnesses in childhood. This is in keeping with the original work of Fry which showed a relationship between the common respiratory illnesses within the spectrum of the catarrhal child.[57]

Inhalation challenge

Much work has emerged in recent years on the use of inhalation provocation tests in asthma. These involve the inhalation of increasing concentrations of either histamine or methacholine and measuring the fall in lung function either by peak expiratory flow rate or forced expiratory volume. The data are then plotted to form a response curve and by interpolation, the concentration of histamine which would produce a 20% change in lung function (PC_{20}) is calculated. It is thus possible to make objective measurements of bronchial hyperresponsiveness or hyperreactivity, which is best defined as the exaggerated constrictor response of the airways to a wide variety of specific and non-specific stimuli.[53] Some workers argue that bronchial hyperresponsiveness is a fundamental part of asthma and should be included in its definition[91] while others have shown bronchial hyperresponsiveness to occur as a natural phenomenon in the non-asthmatic population.[92,93]

The relationship between bronchial hyperresponsiveness and clinical symptoms is not clear cut as only two thirds of clinically diagnosed asthma sufferers have demonstrable hyperresponsiveness on inhalation testing and one third of subjects demonstrating hyperresponsiveness are asymptomatic.[94-97] Nevertheless, inhalation tests of bronchial hyperresponsiveness are becoming increasingly used, particularly in the laboratory setting. Pattemore tested more than 2000 schoolchildren in New Zealand and commented 'bronchial challenge testing [by inhalation] is an important tool of respiratory research, but cannot reliably or precisely separate asthmatics from non-asthmatics in the general community'.[51] In this sort of testing, as in the exercise challenge,[88,89] considerable overlap has been shown between bronchial responsiveness, current asthma and current respiratory symptoms.

The way forward

Morbidity in asthma is still caused by underdiagnosis and inappropriate treatment.[35] There is, therefore, every indication that screening for undiagnosed asthma should help, and primary health care is well placed for this.

Although doctors should be aware of the difficulties in defining asthma, they should not be hampered by the arguments, and should accept the definition for childhood asthma put forward in the consensus statement.[35] Audit is now an integral part of primary care and general practitioners should start to identify the prevalence of current asthma, that is, children who have had symptoms of their asthma within the last 12 months. This should give a starting point for determining the extent of undiagnosed asthma in the community.

Screening for asthma by questionnaire is relatively easy, cheap and reliable, and a compilation of validated questions used in many studies is given in Appendix 1. Such a questionnaire can be used as a guide in any screening programme and is not intended as a comprehensive catalogue of all the necessary questions that can be used to help make a diagnosis.

An exercise test can be used successfully in the context of a research project but does not necessarily need to be used as a screening procedure. It can be reserved for those patients in whom the diagnosis is still in doubt or where exercise-induced asthma may cause the child undue difficulty in school, at games or at play. Exercise testing does not require a laboratory setting but needs to be medically supervised with bronchodilators available if required. Supervision, encouragement, a sense of achievement and fun are all motivating factors.

There is now increasing evidence to support the concept that chronic obstructive airways disease in adulthood begins in childhood.[63-66] Improved systems of monitoring of respiratory ailments in childhood will mean better epidemiological data being made available to afford an improved understanding of the relationship between asthma and other respiratory illnesses both in childhood and adulthood. Computers will aid surveillance and observation, and accurate recording needs to be encouraged. We should seize the opportunity to look at catarrhal illnesses in children as a possible precursor to latent or potential asthma.

As primary health care is at the forefront of asthma management, early diagnosis as a result of screening should lead to early intervention. By adopting a stepwise approach to management the use of prophylactic therapy should lead to better asthma control and improved quality of life for patients.

Appendix 1. Questions which may be used on a questionnaire screening for asthma in children.

Wheeze

- Has your child ever had episodes of wheeziness in the chest (that is, breathing with a whistling sound coming from the chest and not the throat)?
- Does your child wheeze with exercise, at night, with colds, without colds, in cold air or in contact with animals?
- Does your child suffer from attacks of shortness of breath with wheeze, wheezing or shortness of breath on exercise?

Cough

- Does your child cough more (or get more coughs) than other children?
- Does your child usually (that is, more than half of the time) cough with colds, with exercise, without colds, at night, with emotion or on contact with animals?

Chest tightness

- Has your child ever said his/her chest felt tight or the child's breathing become difficult? Does this occur with exercise, cold air or at night?

Shortness of breath

- Does your child get more short of breath than other children of same age when walking or when running?
- Has your child ever complained of unexpected breathlessness at rest (that is, feeling out of breath or puffed)?

Chest illnesses

- Has your child missed school for more than one week on two or more occasions in the last 12 months or been told that he or she has had bronchitis or a chest infection on two or more occasions in the past 12 months?
- Do colds usually (more than half of the time) go on to your child's chest?

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Acknowledgements

My thanks to Mrs S Looker and Mrs R Thomas for their help in preparing the manuscript and the West Glamorgan Family Health Services Authority for their support.

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