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REVIEW ARTICLE

Population-Based Screening or Case Detection for Asthma: Are We Ready?

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ABSTRACT

Asthma is a prevalent health problem for which there are effective treatments. By identifying people with asthma and treating them effectively, the burden of asthma in the United States should be reduced. Detecting people with asthma through screening programs seems a logical approach to the problem. This article assesses our readiness for population-based screening and case detection programs for asthma and examines these activities in relation to World Health Organization criteria for determining the appropriateness of screening programs. Given that, at this time, a number of the criteria have not been met, we conclude that population-based approaches to screening and case detection of asthma are of unproven benefit and need further research. A more appropriate focus may be to ensure that all people who are diagnosed with asthma receive appropriate medical care.

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INTRODUCTION

Asthma is a highly prevalent and growing health problem with significant impact worldwide. It is among the most common chronic conditions in the United States, affecting an estimated 14.6 million people in 1996 (1). Asthma prevalence is significantly higher among children than adults and is higher among African-Americans than other racial groups. An increase in prevalence has been demonstrated in many countries of the world, a rise not explained solely by increased awareness or statistical artifact (2). In 1999 in the United States, asthma accounted for an estimated 1,997,000 emergency department visits; 478,000 hospitalizations; and 4657 deaths (1). Among diseases commonly seen in outpatient departments, asthma was the fifth most frequent in 1992 (3). Children with asthma miss an average of twice as many school days as other children; 21% of children with asthma in one study population missed more than 2 weeks of school per year because of asthma (4). One study of adults with asthma found that one in six either limited work, changed jobs, or ceased work altogether because of asthma (5). In another study, 20% of people of all ages restricted their daily activities as a result of their asthma (6). The estimated direct and indirect monetary costs for asthma totaled \$10.7 billion in 1994 (7). Much of this disability and disruption of daily lives is unnecessary because effective treatments for asthma are available and are outlined in nationally endorsed clinical practice guidelines (8). The keys to reducing the burden of asthma are to identify people with the condition and to ensure effective disease management.

Epidemiologic surveys consistently reveal a higher prevalence of current wheeze, or wheeze with exercise, than of a diagnosis of asthma (9). However, wheeze or wheeze with exercise are not specific for asthma; thus, if such symptoms alone were used to identify people as having asthma, some people so identified would have diseases other than asthma. On the other hand, these survey findings could reflect an underdiagnosis of asthma, which can have serious implications. Early diagnosis, suitable management, and appropriate monitoring of disease may prevent the serious physical and psychosocial morbidity and mortality related to asthma, which have been increasing over the last two decades. Thus screening the population for asthma seems a logical approach to the problem.

In this article, we assess our readiness to implement population-based screening for asthma in community settings. The assessment examines the proposed

screening activities in relation to the World Health Organization's (WHO) suggested criteria for determining the appropriateness of screening programs (10). In addition, we apply these screening criteria to community-based case detection programs.

POPULATION-BASED SCREENING AND CASE DETECTION

The classic epidemiologic definition of screening a population for disease is the presumptive identification of unrecognized disease or defect by tests, examinations, or other procedures that can be applied rapidly to sort out *apparently well* people who probably have a disease from those who probably do not (11). Cervical smear testing is an example of this type of screening. Unfortunately, the term "screening" is frequently and inappropriately used to label other population-based approaches to disease detection, a label that can lead to confusion.

In contrast to population screening programs, population-based case detection efforts presumptively identify people with unrecognized or undiagnosed disease by the application of tests, examinations, or other procedures that can be applied rapidly to sort out people who *have symptoms* of the disease from those who do not. This process can be used to identify people with asthma symptoms but without a diagnosis, and to identify those with an asthma diagnosis but with poorly controlled disease. The term "screening" is frequently and inappropriately used to label both these approaches to disease control, a label that can lead to confusion. The distinction between population-based screening and population-based case detection is that, with the latter, all people who are identified have symptoms, and their identification is based on those symptoms.

Given that the burden of existing asthma can be significantly reduced by effective therapy (8), numerous programs have proliferated recently to identify people with undiagnosed or poorly controlled asthma by evaluating large groups of people in a variety of public settings, such as schools and community centers. These programs are extrapolating methods and outcomes used in classic population-based screening to population-based case detection programs. Even though these programs are focused on "case detection" rather than classic population-based screening, they use approaches and health resources similar to those used for screening, and they expose whole population groups to testing measures. Thus, as with population-based screening, population-based

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case detection programs should be assessed for effectiveness and adherence to public health principles before widespread implementation.

**SCREENING CRITERIA AS APPLIED
TO ASTHMA**

WHO and other organizations have proposed criteria for ethical and scientifically acceptable population-based screening (10) (Table 1). Even though the criteria were developed to evaluate screening programs to detect asymptomatic rather than symptomatic people (i.e., for population-based screening rather than case detection), we believe some of the criteria also to be useful for case detection programs. And, regardless of the fact that we cannot currently identify people with presymptomatic asthma (screening), we believe it to be worthwhile to explore the WHO criteria in relation

to screening and case finding. As a result, we will consider each of the criteria in turn to assess separately our readiness for population-based asthma screening and for community-based asthma case detection.

**The Condition Must Be an Important
Health Problem**

As previously discussed, asthma clearly is a serious public health problem in terms of both prevalence and burden.

**The Natural History of the Disease State
Should Be Understood**

Although much has been learned about the natural history of asthma, much remains a mystery.

Table 1. WHO criteria for community-based screening as related to asthma.

The condition must be an important health problem
Asthma is an important public health problem
The natural history of the disease state should be understood
The natural history of asthma is not adequately understood
There are indications that detection of mild disease would have little public health impact in terms of preventing disease progression
There should be a recognizable latent or early symptomatic stage
There is no known latent stage
Mild intermittent asthma may be an early stage of moderate or severe asthma
There should be accepted treatment for patients with recognized disease
NAEPP EPR-2 guidelines ⁸ are well-accepted by professional organizations, but there is wide variability in implementation
There should be an agreed policy on treatment, including whom to treat as patients
NAEPP EPR-2 guidelines ⁸ are accepted
Facilities for diagnosis and treatment should be available
Treatment facilities are available in most communities in the United States
It is uncertain whether existing facilities and staff could absorb the added diagnostic and treatment burden resulting from widespread implementation of screening or case detection programs
There should be a suitable screening test or examination
No specific test has been identified with adequate validity, reliability, and yield for a screening or case detection program
The screening test should be acceptable to the population
Acceptability cannot be determined until a valid and reliable test is identified
The cost of screening (including diagnosis and treatment) should be economically balanced in relation to competing health care needs
No adequate data are available; data must come from a screening program
Screening should be continuous
Continuous screening is dependent on the existence of a screening program

Source: Wilson JMG, Junger F. Principles and practice of screening for disease. Public health papers No. 34. WHO, Geneva, 1968.

What happens in the preclinical stage of asthma is not understood sufficiently well that some type of marker (e.g., a blood test) could identify stages in the progression of the disease. Nor is it known whether intervention would change the course of disease if such a marker were to be identified, issues pertinent to screening. Relevant to case detection, there is somewhat more, though still limited, information available on the natural history of asthma. Findings from the Melbourne Asthma Study suggest that the majority of children with mild wheezing had a benign course into adulthood. Children with asthma mostly continued wheezing into adult life, and the more troubled they were as children, the more likely that the symptoms continued (12). Recent updates to the National Asthma Education and Prevention Program (NAEPP) guidelines (8) state that, for children 5–12 years old with mild or moderate asthma, “treatment provides control but does not modify the underlying disease process” (13). All of this suggests that detection of mild disease may have little public health impact in terms of preventing disease progression through early detection of asthma in children older than 5 years of age.

There Should Be a Recognizable Latent or Early Symptomatic Stage

No early nonsymptomatic period has been identified in the natural history of asthma. No marker exists that, when present, identifies asthma before symptoms are evident, so classic screening is not possible. This criterion does not apply to case detection programs because cases are identified as a result of symptoms but without distinction as to stage of symptoms.

There Should Be Accepted Treatment for Patients with Recognized Disease and an Agreed Policy on Treatment, Including Who to Treat as Patients

National and international guidelines for the treatment of asthma have been widely accepted by professional organizations. If population-based case detection efforts are undertaken, these guidelines should be used to guide treatment of people who are identified as having asthma.

Facilities for Diagnosis and Treatment Should Be Available

Facilities for the diagnosis and treatment of asthma are available in most communities in the United States. However, it is not known whether existing facilities could handle the influx of people identified in screening or case detection programs who would require diagnostic and, possibly, treatment services. Should it be found that facilities are lacking, resources would need to be directed to increasing available clinical services. Recently reported results indicate that links of school-based screening (case detection) programs with good clinical care, though essential, proved to be the most difficult piece of the project's case finding and education efforts (14).

It is known that many people with asthma do not receive high-quality medical care—care that is delivered in accordance with the NAEPP guidelines (15–21). Inadequacy of medical care is perhaps the greatest obstacle to reducing the current burden of asthma in the United States, an obstacle that neither a screening program nor a population-based case detection program would address.

There Should Be a Suitable Screening Test or Examination

Numerous efforts have been made to identify a suitable screening test for asthma—one that is reliable and valid. Some efforts to screen populations for asthma, such as the free-running test or the step test, have attempted to use exercise testing to identify asymptomatic individuals with bronchial hyperresponsiveness (BHR) (22,23). This approach presumes that BHR is a presymptomatic stage of asthma, which is not always the case. Although BHR is a characteristic of asthma, it is not unique to asthma, and some patients with asthma do not have it. Another form of population screening that has been attempted uses spirometry to identify people with asymptomatic airway obstruction (24). However, lung function fluctuates over time in people with asthma, so a single spirometry measure by itself will not be a reliable indicator of disease. A priority for research is to develop a screening test that could be used to identify asymptomatic populations likely to develop asthma. Until such a test becomes available, population-based screening for asthma is not possible.

From the standpoint of case detection, numerous efforts have been and are being made to formulate



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a suitable combination of tests and questions that could be used to identify people with asthma (23–26). One significant challenge in these efforts is the absence of an accepted gold standard for the diagnosis of asthma, although physician-diagnosed asthma and BHR have been used as standards, and NAEPP guidelines might also be considered. Despite their limitations, some existing approaches may have acceptable sensitivity and specificity compared with physician diagnosis (25). Key asthma organizations could contribute to the development and acceptance of standard tools by recognizing and agreeing on the appropriateness of specific approaches.

For example, some case detection efforts have used questionnaires in conjunction with peak flow reading or spirometry, but young children—those younger than 6 years of age, an important population for early diagnosis of asthma—may not be able to perform the maneuvers needed to measure peak expiratory flow or spirometry. As a result, approaches recommended for case detection in populations of young children may need to be different from those recommended for older children and adults.

The Screening Test Should Be Acceptable to the Population

Until a suitable screening or case detection test or examination is identified, researchers cannot assess its acceptability to the population. Case detection methods using questionnaires, peak flow measurements, or spirometry are noninvasive and, thus, likely to be acceptable.

The Cost of Screening (Including Diagnosis and Treatment) Should Be Economically Balanced

Appropriate assessment of the cost-effectiveness or cost-benefit of population-based case detection programs for asthma will not be possible until there are valid and reliable tests that identify undiagnosed disease, the treatment of which improves the health of the tested population. Only then can economic determinations be made to establish the priority of population case detection programs among other public health issues.

We speculate that many previously undiagnosed cases identified through a case detection program would have mild disease. However, without knowing

the severity of illness of people who would be identified through a case detection program, the impact on the most costly outcomes—hospitalizations, emergency care, and medications—is unknown. Conceivably, a population-based case detection program might result in a higher cost for benefit than would improved recognition of the disease and its severity by clinicians and patients and appropriate follow-up of people with already diagnosed but poorly controlled asthma. It is important that we understand the cost/benefit of screening/case detection programs before widespread implementation.

Screening Should Be Continuous

Neither screening nor case detection should be a one-time event, but continuous screening and case detection in a population to identify new cases is dependent on the existence of appropriate baseline testing. After appropriate testing is identified, researchers will be able to assess the appropriate frequency for continued screening or case detection.

COMMENT

Given that asthma is widespread and costly, ways must be found to decrease the burden of the disease on people with asthma and on their families and to decrease the burden of cost on the health care system. According to the knowledge we have today, with the exception of some work-related asthma cases, asthma is not a preventable disease. However, even with the challenges related to diagnosis and treatment, asthma can be controlled for most patients, and they should expect nothing less.

Three categories exist for people who theoretically could be identified by population-based approaches as being at high risk for developing asthma (identified by screening) or as having asthma (identified by case detection): (1) people who will have symptoms in the future and who may now have some unknown “markers” of disease, (2) people with the symptoms of asthma who have not been diagnosed, and (3) people with diagnosed disease whose asthma is not properly controlled. As previously discussed, at this time, preclinical stages of asthma cannot be identified. Although no comparisons exist between population-based approaches and clinically based programs for the detection of people with asthma, improving case detection in the clinical

setting might be as effective as population testing in detecting symptomatic but undiagnosed asthma. Furthermore, detection in a clinical setting has the advantage of eliminating the referral step that would be required in a population-based approach to case detection. Asthma is one of the most common chronic diseases, so symptoms potentially caused by asthma should already be noted as part of the review of systems for any regular physical or well-child exam. Identification is the first step toward ensuring quality evaluation and management for all newly identified patients with a possible diagnosis of asthma.

However, a major problem is inadequate management of asthma in people already diagnosed (12–18). Reasons for this problem are many and complex; however, the solutions should be our highest priority. We must ensure state-of-the-art management for all currently diagnosed patients with asthma. Of course, disease management includes education about the disease and training in the skills needed to control the disease for patients, their families, and, indeed, the general population. Educational campaigns should focus on increasing people's awareness of asthma symptoms, symptom control, and the benefits of seeking appropriate medical care for asthma.

Where are we now with population screening and case detection for asthma? Given our incomplete understanding of the natural history of asthma and the lack of a test to identify asymptomatic persons who will develop asthma, true screening for asthma is not possible.

For case detection, as for screening, a number of the criteria for a population-based approach have not been met. These criteria were developed for screening of asymptomatic populations and may not be completely appropriate for judging case detection programs. Nevertheless, the barriers to implementing case detection programs are similar to the barriers to implementing screening programs: incomplete understanding of the natural history of the disease, the lack of a widely accepted and endorsed test or examination with proven validity, and the lack of science-based assurance that some significant health outcome will show improvement commensurate with the cost of detection, diagnosis, and treatment for the tested population. Research is still underway on suitable approaches to detecting cases of asthma in the population.

Thus, until we know more about asthma, further understanding as to whether and how mild asthma progresses to more severe disease, and whether treatment of patients of any age with mild asthma can

prevent this progression or otherwise improve health, population-based approaches to case detection of asthma should be considered of unproven benefit and an appropriate topic for research programs. When the cost-effectiveness of population-based case detection programs can be defined, more widespread implementation of these programs might be appropriate. At present, resources might better be focused on the research necessary to address the issues surrounding these population-based approaches to screening and case detection, on improving the recognition of people with poorly controlled asthma whether currently diagnosed or not in the clinical setting, and on ensuring that all people who have asthma receive appropriate care. The asthma research and intervention communities would benefit from having existing research results on such programs consolidated and made widely available.

Numerous organizations are promoting a variety of activities under the umbrella of "screening" for asthma, offering important opportunities to define the potential role of this intervention in the overall strategy of reducing the burden of asthma. It is clear that the term "screening" has expanded to include identification activities that extend beyond the traditional epidemiologic definition of this term. To eliminate confusion about the different types of activities, a standard and agreed-upon terminology is needed to distinguish among three distinct identification activities: (1) *screening* to identify people without symptoms who are at high risk for developing the symptoms of asthma, (2) *case detection* to identify people with symptoms of asthma but without a diagnosis, and (3) *identifying poorly controlled cases* who already have a diagnosis of asthma but who also have some other characteristic, such as inappropriate medication or lack of adherence with a treatment regimen, which might make them a good candidate for intervention.

Before resources are used to implement community-based case detection, research should be undertaken to assure that this is a cost-effective approach to reducing the health burden of asthma. This research must include follow-up diagnostic assessments of people identified as having asthma during the case detection process, and evaluation of whether appropriate care is being provided for those identified as having asthma. Continued follow-up is necessary to document an improved health outcome in those people receiving treatment. It is only this improved health outcome in people who have been screened or who have participated in case detection programs that justifies the existence of these



programs. A cost-benefit assessment should weigh the cost of the screening or case detection procedures, the diagnostic and treatment costs of those people screened and the benefits derived from the program. This kind of research is needed to allow comparisons between the benefits of population-based case detection and those of other public health interventions and to give priority to those interventions that are most cost effective.

Looking toward the future of population-based asthma screening and case detection, we see that continued efforts to further understand the natural history of asthma are essential. Assessing our readiness today, we conclude that our focus should be on improved detection of asthma and identification of poorly controlled asthma in the clinical setting and increased application of quality care—approaches that can be applied immediately with known positive impact on people with asthma.

REFERENCES

1. Mannino DM, Homa D, Akinbami LJ, Moorman JE, Gwynn C, Redd SC. Surveillance for asthma—United States, 1980–1999. In: Surveillance Summaries, March 29, 2002. MMWR 2002; 51(No. SS-1).
2. National Institutes of Health, National Heart, Lung, and Blood Institute. Global strategy for asthma management and prevention: 2002; NIH publ. No. V002-3659, 14–15.
3. National Institutes of Health, National Heart, Lung, and Blood Institute. Morbidity & mortality: 1996 chartbook on cardiovascular, lung, and blood diseases. May, 1996.
4. Fowler MG, Davenport MG, Garg R. School functioning of U.S. children with asthma. *Pediatrics* 1992; 90(6):939–944.
5. Blanc PD, Eisner M, Katz PP, Trupin L, Earnest G, Yelin EH. Work loss among adults with asthma and allergic rhinitis from a random population survey. *Am J Respir Crit Care Med* 2000; 161:A622.
6. U.S. Public Health Service. NCHS healthy people 2000 review 1998–1999. Hyattsville, MD, 1999.
7. Weiss KB, Sullivan SD, Lyttle CS. Trends in the cost of asthma in the United States. *Allergy Clin Immunology* 2000; 106(3):493–499.
8. National Institutes of Health, National Heart, Lung, and Blood Institute. Guidelines for the diagnosis and management of asthma. NIH Publ No. 97-4051. April, 1997.
9. International Study of Asthma and Allergies in Childhood (ISAAC) Steering Committee. Worldwide variation in prevalence of symptoms of asthma, allergic rhino conjunctivitis, and atopic eczema: ISAAC. *Lancet* 1998; 351:1225–1232.
10. Wilson JMG, Junger F. Principles and practice of screening for disease. Public Health Papers No. 34. Geneva: WHO, 1968.
11. Commission on Chronic Disease. Chronic illness in the United States. Vol. 1. Commonwealth Fund, Cambridge: Harvard University Press, 1957:45.
12. Philan PD, Roveverson CF, Olinsky A. The Melbourne Asthma Study: 1964–1999. *J Allergy Clin Immunol* 2002; 109(2):189–194.
13. Executive Summary of the NAEPP Expert Panel Report: Guidelines for the Diagnosis and Management of Asthma—Update on Selected Topics 2002. www.nhlbi.nih.gov/guidelines/asthma (accessed June 2002).
14. Gerald LB. Research Program on Asthma Management at School. National Asthma Education and Prevention Program (NAEPP) Coordinating Committee Meeting, Arlington, VA, June 2002.
15. Goodman DC, Lozano P, Stukel TA, Chang C, Hecht J. Has medication use in children become more frequent, more appropriate, or both. *Pediatrics* 1999; 104(2 Pt 1):187–194.
16. Legorreta A. Compliance with national asthma management guidelines and specialty care: a health maintenance organization experience. *Arch Intern Med* 1998; 158(5):457–464.
17. Jatulis D. Preventive pharmacologic therapy among asthmatics: five years after publication of the guidelines. *Ann Allergy Asthma Immunol* 1998; 81(1):82–88.
18. Hartert T. Inadequate outpatient medical therapy for patients with asthma admitted to two urban hospitals. *Amer J Med* 2000; 1:386–394.
19. Finkelstein JA, Brown RW, Schneider LC, Weiss ST, Quintana JM, Goldmann DA, Homer CJ. Quality of care for preschool children with asthma: the role of social factors and practice settings. *Pediatrics* 1995; 95(3):389–394.
20. Gottleib DJ, Beisser AS, O'Connor GT. Poverty, race, and medication use are correlates of asthma hospitalization rates. A small area analysis in Boston. *Chest* 1995; 108:28–35.
21. Eggleston PA, Malveaux FJ, Butz AM, Huss K, Thompson L, Kolodner K, Rand CS. Medications used by children with asthma



- living in the inner city. *Pediatrics* 1998; 101(3 Pt 1):349–354.
22. Feinstein RA, Hains CS, Hemstreet MP, Turner-Henson A, Redden DT, Martin B, Erwin S, Bailey WC. A simple step test protocol for identifying suspected unrecognized exercise-induced asthma (EIA) in children. *Allergy Asthma Proc* 1999; 20(3):181–188.
23. Demissie K, White N, Joseph L, Ernst P. Bayesian estimation of asthma prevalence, and comparison of exercise and questionnaire diagnostics in the absence of a gold standard. *Ann Epidemiol* 1998; 8(3):201–208.
24. Muller GA, Eigen H. Pediatric pulmonary function testing in asthma. *Pediatr Clin North Am* 1992; 39:1243–1257.
25. Joseph CL, Foxman B, Leickly RE, Peterson E, Ownby D. Sensitivity and specificity of asthma definitions and symptoms used in a survey of childhood asthma. *J Asthma* 1999; 36(7):565–573.
26. Gerald LB, Redden D, Turner-Hensen A, Feinstein R, Hemstreet MP, Haines C, Brooks CM, Erwin S, Bailey WC. A multi-stage asthma screening procedure for elementary school children. *J Asthma* 2002; 39(1):29–36.