# Mass Screening of School Children for Heart Disease 

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MASS SCREENING programs for the detection of heart disease in children have been conducted since 1959 (1-5). Recently such programs have been facilitated by the use of the PhonoCardioScan (A), a portable analogdigital computer ( $6-8$ ). However, although much has been written about the "delabeling" of children with innocent murmurs, to our knowledge no effort has been made to carry this out in mass screening programs.
In the mass screening program reported here, in addition to labeling children with heart disease an attempt was made to delabel those who had a history of rheumatic fever, heart disease, or murmur but were found to have no present evidence of heart disease.
From October 1967 to April 1968, 3,518 fourth grade children in the 56 elementary schools of the Sacramento City Unified School District were screened with the PhonoCardioScan. The unit was purchased and loaned to the school district by the Sacramento-Yolo-Sierra Heart

[^0]Association. The program was approved by the Sacramento Society for Medical Improvement (the County Medical Society). Funds for a technician and a cardiologist were provided through a community service project grant from the heart association.

## Methods

At the beginning of the school year, school principals and nurses were informed of the program and shown a 15 -minute color and sound motion picture, "Screen One" (A). About 1 or 2 weeks before the program was to start, the principals and nurses explained the program and showed the film to assembled children, parents, and teachers.
The parents were asked to fill out a consent form which included a brief medical history (whether the child has or has had rheumatic fever, heart disease, heart murmur, or restrictions because of a heart problem) and the name of the family physician or the clinic attended by the child. Explanatory letters, sent to the parents from the principals and the school district's director of medical services, included a description of the procedure and an assurance that it would cause no harm or discomfort.

Using the PhonoCardioScan, a nurse-technician assisted by school nurses screened from 75 to 100 children daily, 3 days a week, at each school. Parent volunteers guided the children in and out of the examining area and prepared
them for screening. Girls and boys were screened separately.

A week after the screening, a pediatric cardiologist visited each school to examine the following children: (a) with a machine positive result, (b) with a technically unsatisfactory machine result, (c) with a history of rheumatic fever, heart disease, or murmur, ( $d$ ) who had been absent at the time of screening, and (e) whose parents requested an examination. The cardiologist spent 2 to 3 hours a week making these examinations.

After completing his followup observations, the cardiologist notified the school district director of medical services which pupils had suspected heart disease and which ones with a history of rheumatic fever, heart disease, or murmur had "nondisease"-no evidence of heart disease. The director then sent letters to the parents indicating whether the tests had been negative or positive and to the family physicians when the results were positive or when delabeling was indicated.
The school nurses were given the names of the children thought to have heart disease, and in subsequent weeks they checked with the parents to see whether they had sought further evaluation or medical care.

## Results

Of a total of 3,944 fourth grade children, 3,518 or 89 percent were examined. Machine positive results occurred for 6 percent, or 204 children, and technically unsatisfactory machine results occurred for 7.5 percent, or 271 children. Since the program did not include machine re-screening of children with suspected positive machine results, as is usually recommended ( $6-8$ ), the cardiologist followup examination rate of 12.5 percent is high compared to other studies. The results of the followup examinations are shown in table 1.

Fifteen children who needed to be examined by the cardiologist but were absent on the day of his visit to the school were given appointments at his office. Two children with low-intensity, high-frequency late apical systolic murmurs were missed by the PhonoCardioScan. The cardiologist discovered these two machine false negative results during his examination of the children with positive histories.

Initially, definite organic heart lesions were detected in 18 children and 24 were suspected to have heart disease. After electrocardiograms and chest $X$-rays for 20 of the children thought to have heart disease, pediatric cardiology consultation for six children, and cardiac catheterization of two, 20 children were found to have definite organic lesions and seven were still considered to have suspected conditions. Of these 27 children, 16 had histories of murmurs or heart disease and the conditions of 11 had not been previously recognized.

For many of the children with previously known lesions, the exact diagnosis was clarified through their participation in the program. The types of lesions are shown in table 2.

Of 161 children for whom a history of rheumatic fever, heart disease, or murmur had been reported, 145 or 90 percent were found to have no evidence of these conditions. A letter was sent to the family physicians of these children with "nondisease" which read, in part: "Many doctors feel that the major value of school heart screening programs is not the identification of organic disease but the potential removal of the stigma of a diagnosis of heart disease in children with suspicious past histories of heart problems and of children with innocent or functional murmurs." We plan in the future to determine how many of these children are on unnecessary restricted activity programs.

Initially, we had planned to obtain electro-
Table 1. Results of postscreening examinations by pediatric cardiologist, by reason for examination

| Reason | Number examined | Number with definite heart disease | Number with suspected heart disease |
| :---: | :---: | :---: | :---: |
| Machine positive | 204 | 12 | 16 |
| Technically unsatisfactory machine results | 271 | 2 | 5 |
| History of rheumatic fever, heart disease, or murmur $\qquad$ | 57 | 2 | 0 |
| Absent on screening day. $\qquad$ | 150 | 2 | 3 |
| Examination requested <br> by parents. | 7 | 0 | 0 |
| Total | 689 | 18 | 24 |

Table 2. Number of children with previously known or unknown heart disease, by types of lesions

| Heart disease | Known | $\begin{gathered} \text { Un- } \\ \text { known } \end{gathered}$ | Total |
| :---: | :---: | :---: | :---: |
| Congenital: |  |  |  |
|  |  |  |  |
| Coarctation ${ }^{1}$ - | 2 | 1 |  |
| Ventricular septal defect ${ }^{1}$-- | 2 | 1 |  |
| Pulmonary stenosis------- | 2 | 0 |  |
| Aortic stenosis | 1 | 0 |  |
| Endocardial cushion defect- | 0 | 1 |  |
| Patent ductus arteriosus ${ }^{1}$-- | 1 | 0 |  |
| Otheralogy of Fallot ${ }^{\text {1 }}$------ | 1 | 0 |  |
| Mitral insufficiency ${ }^{2}$ | Other: |  |  |
| Ventricular extrasystoles.-- | 0 | 2 | $\stackrel{3}{2}$ |
| Suspected cases: |  |  |  |
| Pulmonary stenosis | 1 | 2 | 3 |
| Atrial septal defect- | 0 | 1 |  |
| Endocardial cushion defect- | 1 | 0 |  |
| Pulmonary artery hypertension. | 1 | 0 |  |
| Ventricular septal defect.- | 1 | 0 | 1 |
| Total | 16 | 11 | 27 |
| ${ }^{1}$ One case postoperative. <br> ${ }^{2}$ Late apical systolic murmu or both (11). | rs or no | ejection | click |

cardiograms in the school at the time of the cardiologist's visit. However, this did not prove to be practical, and followup electrocardiograms were obtained at the cardiologist's office at no cost to the parents. After the cost of the PhonoCardioScan was amortized, the cost of the program was $\$ 1,829-52$ cents per child screened or approximately $\$ 166$ per unknown case detected.

## Discussion

Acheson (9) stated that diseases suitable for mass screening must fulfill the following five criteria: ( $a$ ) the incidence of disease must be significant, ( $b$ ) the disease should be dangerous to life, (c) a single sign should indicate a high probability of the presence of the disease, ( $d$ ) eliciting the diagnostic sign should be simple, economical, and unobjectionable to the patient, and (e) there should be a reasonable prospect that cure or prevention of progression can be achieved after identification. Use of the PhonoCardioScan and the design of the program we have described fulfill all of these criteria.

The incidence of heart disease and "nondisease" in school children is significant, about 10 cases per 1,000 children (1-5, 10). About
half of the school children with heart lesions are unrecognized (1-5), and 10 to 20 percent of the cardiac lesions in school children are potentially dangerous to life. Additionally, awareness of minor defects is desirable in order to minimize the risk of complicating bacterial endocarditis.

More than 95 percent of the school children with heart disease have cardiac auscultatory abnormalities, either systolic or diastolic murmurs, or both, or abnormal splitting of the second sound. The use of the PhonoCardioScan has proved to be a simple, economical, and unobjectionable method for the detection of these auscultatory abnormalities. The unit also can detect marked right axis deviation, bradycardia, tachycardia, and arrhythmia. Furthermore, the fifth criteria of Acheson is also met, because almost all of the significan't cardiovascular lesions in school children are due to congenital defects which can be repaired at low risk.

As mentioned earlier, the design of our mass screening program allowed an opportunity for the important task of delabeling as well as labeling heart disease. Bergman and Stamm (10) recently reported that of 93 children reported to previously have had either acute rheumatic fever or "something" wrong with the heart, 75 were found to have no evidence of heart disease. Our study revealed that 145 of 161 children with a history of rheumatic fever, heart disease, or murmur had no signs of heart disease. This study was not designed to determine how many of these children had iatrogenic problems, but we hope to obtain such information in the future.

Unfortunately, the opportunity for adequate followup was limited in our program, and this may result in inaccurate labeling and unnecessary restrictions by the parents or the family physicians, or both. However, this potential undesirable byproduct of the program is minimized by direct contact between the pediatric cardiologist and the family physicians and by effective communication of the County Medical Society with all the physicians in the school district concerning the goals, benefits, and potential hazards of the program.

In a pilot study, which we conducted at an elementary school during 1966-67, the fourth grade children were easier to screen than the
fifth or sixth graders because they were less apprehensive and inhibited about "stripping to the waist." Also, ages 9 to 11 seem to be ideal for the detection of most asymptomatic or minimally symptomatic cardiac defects, because most cardiologists consider the end of the first decade as the optimal age for repair of such lesions. If our program were expanded, we would include second and third grade children rather than fifth and sixth graders because of the greater concern of the older children about exposing their bodies.

## Summary

During the 1967-68 school year, 3,518 fourth grade children in the Sacramento Unified. School District were screened for heart disease with the use of the PhonoCardioScan, a portable analog-digital computer. Machine positive or technically unsatisfactory results occurred for 475 children and false negative results for two.

Of 161 children for whom a history of rheumatic fever, heart disease, or murmur had been reported, 145 were found to have no present evidence of these conditions. In an effort to "delabel" the children with "nondisease," a letter was sent to the family physicians which pointed up the value of removing the stigma of falsely labeled heart disease.

Definite organic heart lesions were detected in 20 children and seven were considered to have suspected heart disease. Of these 27 children, 16 had histories of murmurs or heart disease and the conditions of 11 had not been previously recognized.

After the cost of the PhonoCardioScan was amortized, the cost of the program was 52 cents per child or about $\$ 166$ per unknown case detected.

## EQUIPMENT REFERENCE

(A) PhonoCardioScan: Humetrics, 231\% Barry Ave., Los Angeles, Calif. 90064.

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