The Detection of Heart Disease in Children

Results of Mass Field Trials with Use of Tape Recorded
Heart Sounds. II. The Michigan City Study

By Robert A. Miller, M.D., Jeremiah Stamler, M.D., Jacques M. Smith, M.D., Walter S. Milne, M.D., Milton H. Paul, M.D., Irving Abrams, M.D., Alois R. Hastreiter, M.D., Raymond M. Restivo, B.Sc., and Louis deBoer, M.A.

In previous reports a method was described for the detection of heart disease in large populations of school children by a tape-recording system in a mobile trailer. Results were presented of the first mass field trial, accomplished in Chicago public elementary school children. Since the presentation of these reports two additional research and developmental studies have been done, with semiportable equipment but without a trailer. The first surveyed the elementary and junior high school population in Michigan City, Indiana; the second, Chicago area high school students. The results of these investigations are reported in this and the subsequent paper.

The primary objective of the Michigan City study was to test validity of the method. Information on prevalence rates of rheumatic and congenital heart disease, prevalence of previously undetected heart disease, and the community organization for this type of procedure outside Chicago was also obtained for comparison with the Chicago data.

Materials and Methods

The Council for Health Education, Michigan City, Indiana, an organization of civic leaders with previous experience in community-wide health projects, sponsored the project and carried out the organizational work.

An accurate census of the elementary and junior high schools was obtained and a schedule for the physical examinations and tape-recording sessions was prepared. In each school, the school nurse and a member of the tape-recording team gave a lecture-demonstration “pep-talk” to encourage the highest participation rate.

Each child was directly examined by two of six physicians performing the auscultatory examinations. These physicians had each completed at least 1 year of pediatric cardiology training and had previous training in pediatrics or internal medicine. Each physician noted his findings separately on a card. They then conferred to establish a final common opinion: no heart disease, positive for heart disease, or (in a few cases) not classifiable by physical examination alone. The child’s heart sounds were then tape recorded at two sites, apex and base, in the supine position with portable equipment supplied by the Heart Disease Control Program, U. S. Public Health Service. The tape recordings were sent to two cardiologists, specially trained in tape recorded heart-sound interpretation. They noted their findings independently as no murmur, functional murmur, technically unsatisfactory (recall for repeat recording), or positive (suspicious of heart disease, recall for physical examination).

The data from this phase of the study (see below) demonstrated the need for a complete recall procedure.

The physical examinations at final recall were
Table 1

Findings by the Original Examination Team, the Original Tape-reading Team, the Second Examination Team and, the Second Tape-recording Reader Team, Michigan City Heart-sounds Tape-recording Project

<table>
<thead>
<tr>
<th></th>
<th>Original tape-reading team</th>
<th>Second examination team</th>
<th>Second tape-recording team</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No Recall</td>
<td>Recall</td>
<td>All</td>
</tr>
<tr>
<td>A. Number of children</td>
<td>Negative</td>
<td>7963</td>
<td>181</td>
</tr>
<tr>
<td></td>
<td>Not classifiable</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Positive</td>
<td>9</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>All</td>
<td>7976</td>
<td>205</td>
</tr>
<tr>
<td>B. Rate per 1,000 children</td>
<td>Negative</td>
<td>973.3</td>
<td>22.1</td>
</tr>
<tr>
<td></td>
<td>Not classifiable</td>
<td>0.5</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td>Positive</td>
<td>1.1</td>
<td>2.3</td>
</tr>
<tr>
<td></td>
<td>All</td>
<td>974.9</td>
<td>25.1</td>
</tr>
</tbody>
</table>

Results

Of the 8,181 children evaluated, the original examination team listed 283 (3.4 per 1,000) as having organic heart disease by the designated method for organic heart disease examination. The original tape-reading team listed 205 (2.5 per 1,000) as negative for organic heart disease. Of these children, 28 (3.4 per 1,000) were classified as negative (1.1 per 1,000) not classifiable, and the remainder were positive (negative) heart disease (4.3 per 1,000). Of those children examined and found to have heart disease, 19 (2.5 per 1,000) were designated not classifiable by the designated examiner. Five (6.6 per 1,000) had been designated not classifiable, and 181 (22.2 per 1,000) had been designated positive for organic heart disease by the designated method for organic heart disease examination. The original tape reading team listed 32 (3.9 per 1,000) as negative for organic heart disease. Of these children, 19 (2.5 per 1,000) were listed as negative, and 13 (1.6 per 1,000) were unclassified. Of the 205 children evaluated, the original tape reading team listed 205 (2.5 per 1,000) as negative for organic heart disease. Of these children, 19 (2.5 per 1,000) were designated not classifiable by the designated examiner. Five (6.6 per 1,000) had been designated not classifiable, and 181 (22.2 per 1,000) had been designated positive for organic heart disease by the designated method for organic heart disease examination.
Table 2

Findings of the Original and Second Examination Teams in the 185 Children Evaluated by Both Teams, Michigan City Heart-sounds Tape-recording Project

<table>
<thead>
<tr>
<th></th>
<th>Second examination team</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Negative</td>
</tr>
<tr>
<td>Original examination</td>
<td></td>
</tr>
<tr>
<td>team</td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td>153</td>
</tr>
<tr>
<td>Not classified</td>
<td>3</td>
</tr>
<tr>
<td>Positive</td>
<td>6</td>
</tr>
<tr>
<td>All</td>
<td>162</td>
</tr>
</tbody>
</table>

*Includes one child who experienced an acute attack of rheumatic fever between the original and the second examination.

pattern generally paralleled that obtained in the first mass field trial.2

However, nine children (1.1 per 1,000) diagnosed positive by the original examining team were not listed for recall by the tape readers (table 1). This number and rate of apparent false negative by the tape-reading team—nine of 28 children evaluated positive on direct examination, or 32.1 per cent—were considerably greater than in the previous project (three of 34 children or 8.8 per cent false-negatives.)* Therefore, additional investigation of the adequacy and validity of the tape-recording procedure was done, particularly to re-evaluate all children listed as positive, not classifiable, or suspicious for organic heart disease by one or the other procedure, or both.

Assessment of the meaning of the false negatives from the tape readers could not be made without further evaluation of the validity of the direct examination findings. Therefore, a procedure was set up for direct examinations at the recall involving four pediatric cardiologists working individually and in teams (see Materials and Methods).

Findings at Recall—Comparison of Original and Second Examination Teams

Of the 181 children diagnosed negative for heart disease by the original examination team but listed for recall by the original tape-reading team, 157 were actually seen at recall (tables 1 and 2). Of these 157 children, 153 were affirmed as being negative by the second examination team at its final four-man conference finding, four were assessed to be positive.* If this final four-man evaluation with x-ray and electrocardiogram is accepted as definitive in terms of validity for this study, then these four children may be regarded as false-negative diagnoses by the original examination team. In relation to the 23 children designated positive by the second examination team, the four represent a false-negative rate of 17.4 per cent (4/23) (tables 1 and 2).

Of the nine children listed as not classifiable by the original examination team, four were seen at recall; three were diagnosed negative and one positive for organic heart disease by the second examination team (tables 1 and 2).

Of the 28 children listed as positive by the

*Evaluation of a false-positive rate for the tape-reading procedure is meaningless, by definition.1,2 The physicians interpreting the tape recordings list for recall all children whose murmurs they regard as suspicious for organic heart disease. Thus, the nature of the procedure results in a recall rate in the order of 15 to 25 per 1,000, i.e., several-fold greater than the rate of definitive organic heart disease. The basic purpose of the heart-sounds tape-recording procedure is to reduce to a minimum the number of children that must be examined directly by cardiologists.

*Here and subsequently, the four-man final conference finding of the second examination team is presented as the definitive diagnosis, unless otherwise specified. Variations in findings among the four pediatric cardiologists and their two-man teams are discussed separately below.
first examination team, 24 were seen at recall (tables 1 and 2). Of these 24 children, 18 were diagnosed as positive by the second examination team, six as negative. These six children may be regarded as false-positive diagnoses by the original examination team. In terms of the 23 children definitively diagnosed as positive for organic heart disease by the second examination team, these six children represent a false-positive rate of 26.1 per cent (6/23) for the original examination team.

Findings at Recall—Comparison of Second Examination Team and Original Tape-reading Team

Particularly in view of the six apparent false-positive diagnoses among the total of 28 children assessed as positive by the original examination team, it became important in assessing validity of the tape-recording procedure to compare its results with the findings of the second examination team. Analysis of the data in this way revealed that seven children with organic heart disease were missed by the original tape-reading team (table 3). This is a false-negative rate of 30.0 per cent (7/23). It is slightly, but not significantly, lower than the false-negative rate obtained from comparison of these original tape-reading results and the original examination diagnoses (9/23, or 32.1 per cent). Thus, designation of the second examination team's final diagnosis as the definitive criterion for use in assessment of validity of the tape-recording procedure did not result in any significant enhancement of validity.

Findings at Recall—Comparison of Second Examination Team and Second Tape-reading Team

Since the original tape-reading team had interpreted heart sounds recordings made with equipment that had not received widespread field testing, it was conceivable that its false-negative rate of about 30 per cent reflected technical inadequacies and difficulties. For this reason, repeat tape recording was accomplished at the time of recall, utilizing the newest tape-recording equipment extensively field tested in the Chicago area high school project (see subsequent paper). Of the 185 children re-taped and re-examined at recall, 158 were listed as negative (no recall) by the second tape-reading team, 27 were designated as exhibiting murmurs suspicious of organic heart disease and therefore requiring further evaluation (table 4). Of the 23 children evaluated as positive for organic heart disease by the second examination team at its final four-man conference, 17 were listed for recall by the second tape-reading team, whereas six were designated as negative (no recall). Thus, the false-negative rate for the second tape recording and reading was 26.1 per cent (6/23). Again, this is a slightly, but not significantly lower false-negative rate than those obtained from comparison of the original tape-reading results and the examination diagnoses (32.1 per cent and 30.0 per cent, respectively—see above). These findings indicate that comparative quality of the tape recordings in the first and second procedures was apparently not a significant factor in accounting for the false-negative rate.

Table 3

Findings of the Second Examination Team and the Original Tape-recording Reader Team in the 185 Children Evaluated by These Two Teams, Michigan City Heart-sounds Tape-recording Project

<table>
<thead>
<tr>
<th></th>
<th>Second examination team</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Negative</td>
</tr>
<tr>
<td>Original tape-reading</td>
<td>No recall</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Original</td>
<td>Recall</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td></td>
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</tbody>
</table>

Circulation, Volume XXXII, December 1965
Performance of the First and Second Tape-recording Teams as Assessed in the 18 Children Evaluated Positive for Organic Heart Disease by Both the Original and the Second Examination Teams

As indicated in tables 1 and 2, 18 children were designated positive for organic heart disease by both the original and the second examination teams. In view of this complete agreement among all examiners concerning diagnoses in these 18 children, they may be regarded as a "hard core" of positives, for evaluation of validity of the tape-recording procedure. The interpretations of the original and second tape-reading teams in these 18 children were therefore subjected to analysis. Of these 18 children, six were designated negative (no recall) by the original tape-reading team, four by the second tape-reading team, false-negative rates of 33.3 per cent and 22.2 per cent, respectively. These false-negative rates do not differ significantly from each other, and from those obtained with other approaches to validity evaluation (see above).

Between-reader Findings by the First and Second Tape-reading Team

Previous experience demonstrated that tape interpretation by two readers was essential to achieve reasonable validity by the heart sounds tape-recording method. It further indicated that a positive finding by two readers was associated with a significantly greater probability that organic heart disease would in fact be found at recall than with a positive finding by only one of the two tape readers.\(^1\), \(^2\)

In view of these previous observations, analyses were made of between-reader findings in the Michigan City study. Of the 205 children listed for recall by the first tape-recording team, 54 were so designated by both tape readers, 151 were so designated by one reader only. A thorough evaluation of between-reader findings was possible in the 185 children seen at recall and re-examination. Of these, 173 had been recalled because of findings by the original tape-recording team, 43 having been designated for recall by both readers, 130 by one reader only.* Of the 43 children recalled by both readers, 12 (27.9 per cent) were assessed to be positive for organic heart disease by the four-man final conference finding. Of the 130 children recalled by only one of the original tape readers, four (3.1 per cent) were ultimately assessed to have definite organic heart disease.

As already noted, 27 of the 185 children seen at recall and re-examination were designated suspicious for organic heart disease by the second tape-reading team. Of these 27 children, 10 were designated suspicious by two readers; nine of these 10 (90.0 per cent) were assessed as having definite organic heart disease by the four-man final conference finding of the second examination team. Of the 17 children listed as suspicious by one only of the second tape readers, eight (47.1 per cent) were evaluated as positive for definite organic heart disease by the second examination team.

It is evident, therefore, that these results of

\* The remaining 12 children were recalled for reasons other than the findings of the original tape-reading teams.

\(^1\) \(^2\)
the Michigan City study confirm previous observations that recall by both readers is associated with a greater likelihood of an ultimate finding of organic heart disease as compared with recall by one tape reader only.

Comparison of Findings among the Four Pediatric Cardiologists of the Second Examination Team

As indicated above, comparison of findings between the first and second examination teams indicated a significant false-negative and false-positive rate on the part of the original examination team. Widespread experience demonstrates that a certain number and rate of false negative and false positive will inevitably occur, and the only realistic question is that of reducing it to a minimum. Both types of error are of considerable concern, since false stigmatization of heart disease can have negative effects as significant as the failure to detect actual organic heart disease.

In connection with this problem, an evaluation was made of interphysician agreement and disagreement among the four pediatric cardiologists accomplishing the seven evaluations in the 185 children they re-examined. In this assessment, findings of the four-man final conference were again taken as the definitive standard for assessing validity. In each of the six examinations prior to the four-man final conference, only one child was diagnosed false negative, a rate of 4.3 per cent; the number of children designated false positive varied from 0 to 3 (0-13 per cent). Over-all comparison of findings among the four pediatric cardiologists in their seven evaluations revealed that frank negative-positive disagreement of any type occurred for only seven of the 185 children they examined (3.8 per cent). Thus, as was to be expected, examination by qualified pediatric cardiologists minimized the false-negative and the false-positive rates.

Individual Diagnoses, Including Those in the Children Evaluated False Negative by the Tape-reading Teams

Of the 23 children diagnosed as positive for organic heart disease by the second examination team, 18 were children with congenital heart disease (10 previously known, eight undiagnosed prior to evaluation by the tape-recording procedure); five were children with rheumatic heart disease (two previously known, three previously unknown). The specific diagnoses for the 18 children with congenital heart disease were ventricular septal defect (six children), atrial septal defect (one child), aortic stenosis (five children), pulmonary stenosis (one child), aortic stenosis plus aortic insufficiency (one child), coarctation of left pulmonary artery (one child), postoperative transposition of the great vessels (Baffe's operation) (one child), truncus (one child), complete heart block (one child). The specific diagnoses for the five children with rheumatic heart disease were mitral insufficiency (two children), aortic insufficiency (three children).

This ratio of congenital to acquired heart disease (greater than 3 to 1), and this number and per cent of previously undetected disease (11 of 23 children, or 47.8 per cent) are in accord with the previous findings of the Chicago mass field trial.2

Of the six children with false-negative readings by the second tape-reading team, three were diagnosed congenital heart disease (ventricular septal defect, aortic stenosis, complete heart block) and three were diagnosed rheumatic heart disease (aortic insufficiency, two mitral insufficiency) by the second examination team.

Four of these children were also read false negative by the first tape-reading team (the children with ventricular septal defect, congenital aortic stenosis, rheumatic mitral insufficiency). The diagnoses in the three other children missed by the first tape-reading team were pulmonary valvular stenosis and congenital aortic stenosis (two children). These findings attest to the difficulties experienced by the tape-recording procedure in detection of aortic lesions, as previously reported.3

Over-all Prevalence Rate of Congenital and Acquired Heart Disease in Michigan City Elementary and Junior High School Students

In addition to the 23 children evaluated as positive by the second examination team, five
other children were shown to have organic heart disease among the 8,181 originally examined. None of these was seen at recall. They included one child (deceased) with cor pulmonale secondary to cystic fibrosis of the pancreas (diagnosis previously known), one child with transposition of the great vessels (diagnosis previously unknown), and two children with heart disease, type undetermined (diagnosis previously unknown). Thus overall rate of heart disease was 3.4 per 1,000 children (28 of 8,181 children, 14 or 50 per cent previously undiagnosed)–2.4 per 1,000 with congenital heart disease (20 children, eight or 40 per cent previously undiagnosed), 0.7 per 1,000 with rheumatic heart disease (six children, four or 66.7 per cent previously undiagnosed) and 0.2 per 1,000 with heart disease, type undetermined (two children, both previously undiagnosed). As previously stated, no information was obtained on heart disease in the small group of nonrespondents in this study, numbering only 179 children (only 2.1 per cent of the total population of 8,360 children).

Results of Independent Interpretation of the Electrocardiograms and X-rays

The three pediatric cardiologists interpreted the electrocardiograms as positive for heart disease on only nine, seven, and eight, respectively, of the 23 children diagnosed as having definite organic heart disease by the four-man final-conference finding. These are low validity rates of 39.1, 30.4, and 34.8 per cent, respectively. The radiologist interpreted the chest x-ray as positive for heart disease for six of these 23 children, for a low validity rate of 26.1 per cent.

Of the 162 children diagnosed negative for organic heart disease in the four-man final conference, false-positive interpretations were made from the electrocardiogram or x-ray on nine, two, one, and three, respectively. The first of the three electrocardiogram readers deliberately "over-read," in an attempt to minimize false negatives. The result was nine false positives, but nonetheless 14 false-negative and a low-validity rate of 39.1 per cent.

Analysis of the electrocardiographic and x-ray interpretations further indicated that addition of either or both of these procedures to the tape recording would not have enhanced validity. Thus of the six children with organic heart disease missed by the second tape-reading team (table 4), all were also missed—i.e., were likewise false negatives—by electrocardiogram and x-ray.

Discussion

This study of heart disease in children in the elementary schools, public and non-public, of a midwestern non-metropolitan urban community revealed a prevalence rate for all organic heart disease of 3.4 per 1,000, and prevalence rates of organic heart disease, congenital and rheumatic, of 2.4 and 0.7 per 1,000, respectively. These rates are similar to those previously determined for Chicago public elementary school children in the 1959-60 mass survey by the heart-sounds tape-recording method.2 No significant differences in prevalence rates were noted between the metropolis and the non-metropolitan city. The congenital heart disease prevalence rates—2.1 and 2.4 per 1,000 children for Chicago and Michigan City, respectively—are similar. The prevalence rate for rheumatic heart disease for Chicago (1.3 per 1,000) was higher, but not significantly, compared with Michigan City (0.7 per 1,000). From previous experience, it is reasonable to suggest that the small group of 179 nonrespondents in Michigan City included a few children with known heart disease, both rheumatic and congenital, particularly the former (cf. reference 2 and the subsequent paper).

As previously found in Chicago,2 the Michigan City study indicated that congenital heart disease is the predominant form of organic heart disease in elementary school children in the United States today. This is a finding in marked contrast to that of earlier decades. It is fully in accord with mortality data demonstrating a marked decline in death rates from rheumatic fever and rheumatic heart disease among American school age children in the decades since 1920—a decline in the order of 90 per cent or greater.3 Although the prevalence rate of rheumatic heart disease is rel-
DETECTION OF HEART DISEASE: MICHIGAN CITY

Relatively low, the disease has not been eradicated, as is evident from the Chicago and Michigan City findings. Acute rheumatic fever continues to occur endemically. The control of streptococcal infection and its late nonsuppurative complications—and the vigilance of physicians for this purpose—need to be further enhanced.4

The Michigan City study is a thoroughgoing evaluation of the validity of the heart-sounds tape-recording method for the detection of heart disease in children. A careful comparison between the findings by this method and by direct examination was obtained. It had the further advantage of making an assessment of validity based on examination of almost all the children in the community, so that those with positive findings can be regarded as constituting a representative sampling of contemporary heart disease in their age group. Thus this validity study avoided the skewing or bias resulting from arbitrary selection of known cases for insertion as unknowns to test validity (cf. references 2, 5, and the following paper).

As might have been anticipated, this evaluation of validity was complicated by questions concerning the validity of the reference standards, i.e., the diagnoses arrived at by direct examination. Thus, as indicated in the Results, it became necessary to do an extensive evaluation of the validity of the diagnoses made by the first examination team. The conclusion of four pediatric cardiologists in their final conference during the second examination was used as the standard of validity.

The validity rate for the heart-sounds tape-recording method was in the range of 66.7 to 77.8 per cent. This is in general agreement with the rate reported in a recent study from Georgia with this method.5 The two studies also agreed on the higher validity rate for detection of congenital than for rheumatic heart disease.

The validity rate of 66.7 to 77.8 per cent in the Michigan City study was lower than that observed in the Chicago public elementary school study in 1959-60.2 In this earlier effort, selected known cases of heart disease were inserted as unknowns among the children tape recorded in one large Chicago school. As previously noted, the validity rate undoubtedly can be influenced by the nature of the cases inserted (cf. reference 2 and the following paper). Moreover, the physician readers in the Chicago elementary school study of 1959-60 knew which school had been used for testing validity. It is therefore reasonable to infer that the present validity rate of approximately 70 per cent is more representative and meaningful than the earlier one of about 90 per cent. As before, aortic valvular lesions were the major source of difficulty for this method of detecting organic heart disease in school children (cf. reference 2 and the following paper).

The validity rate of about 70 per cent is generally similar to that of other procedures for the mass detection of disease, and is generally regarded as satisfactory for a mass-detection procedure.

The heart-sounds tape-recording procedure has a distinct advantage over direct auscultation by physicians other than pediatric cardiologists, in that it has built-in procedures for minimizing false positives, and for "de-labeling" children with false-positive diagnoses of heart disease (cf. reference 2 and the following paper). (For example, the false positive rate for the first examination team in Michigan City was 26.1 per cent.)

In accordance with the findings in the earlier Chicago public elementary school study, this acceptable rate of validity for the tape-recording method was obtained only when the tapes were interpreted by two trained readers; the validity rate was unsatisfactorily low, i.e., an inordinate number of children with organic heart disease were missed, when the tapes were interpreted by only one reader.

The electrocardiogram and the chest x-ray appear to be inadequate procedures for detection of heart disease in children, and their use did not enhance validity of the heart-sounds tape-recording method.

The recall rate by the original tape reading team was 25.1 per 1,000 (20 children re-
called for direct auscultation of 8,181 tape recorded). In the earlier Chicago elementary school project, the recall rate was 15.0 per 1,000. Thus, the tape-recording procedure for the detection of heart disease makes it possible to eliminate direct auscultation among most children. Direct examination and auscultation of those recalled by tape readers is done in only 1 to 3 per cent of children in these studies, but this group contains at least 70 per cent of all the children with heart disease. It therefore becomes possible to take advantage of the special training of pediatric cardiologists to evaluate the children designated suspicious by the tape-recording procedure. As the data from this study show, this has marked advantages in terms of reducing the rate of false positives, and its medical disadvantages are nil, since the false-negative rate of the tape-recording procedure (about 30 per cent) is no worse than that of physicians (other than pediatric cardiologists) doing direct auscultation. As this study further demonstrated, auscultation by pediatric cardiologists is more accurate than by other physicians. The false-negative rate was reduced to less than 5 per cent, and the false-positive rate ranged from 0 to 13 per cent for a single pediatric cardiologist.

The major remaining difficulty with the tape-recording procedure is the problem of manpower and costs, particularly in relation to the necessity for the tapes to be read by two trained physicians. As indicated in the previous paper, it could be possible to overcome this problem to a considerable degree by automation of the tape interpretation, or by a corresponding procedure involving the use of modern electronic equipment to evaluate the heart sounds of children, and to identify those needing direct auscultation by pediatric cardiologists, without the need to utilize physicians in this first phase of detection. Work on this matter is currently in progress in a number of centers.

Utilization of mass procedures for detection is appropriate only if studies demonstrate a significant prevalence of previously undetected heart disease among children. As in the 1959-60 Chicago mass field trial, the Michigan City study found that approximately 50 per cent of heart disease among school children was previously undetected (cf. reference 2 and the following paper). It would appear sound to infer that significant numbers of children with undetected heart disease exist in the United States at the present time. Therefore, valid procedures for the mass detection of heart disease in children, such as this tape-recording method, have utility for both public health case finding and epidemiologic research purposes.

Conclusions

1. The validity of the tape-recording method, as assessed by the several comparisons possible from the design of this study, was in the range 66.7 to 77.8 per cent. This validity was achieved while requiring pediatric cardiologists to examine directly 25 per 1,000 of the 8,181 children surveyed.

2. The validity rate for a direct examination team with cardiology training was 83 per cent; it missed 17 per cent of the heart disease cases (false negatives). It over-diagnosed 26 per cent (false positives).

3. The tape-recording method has a built-in procedure for minimizing false positives, and for "delabeling" children incorrectly stigmatized as having heart disease.

4. The prevalence rate for organic heart disease in this small midwestern city was 3.4 per 1,000; this rate was of the same order of magnitude reported for Chicago public elementary school children.

5. Congenital heart disease was again found to be 2 or 3 times more prevalent than rheumatic heart disease, reflecting the sharp decline in incidence rates for rheumatic fever and rheumatic heart disease in the United States since 1920.

6. In 47.8 per cent of the children with heart disease, the abnormality was previously unknown to the patient, his family, his physician, and his school just as was found in the Chicago study of children in the 6- to 14-year age group.

7. The yield from either direct auscultation
or the tape-recording method was not significantly increased with addition of the electrocardiogram or the chest x-ray or both; these procedures appear to be inadequate for high-validity detection of heart disease in children.

Acknowledgment
Many organizations and individuals made significant contributions to this cooperative undertaking. It is possible to acknowledge only a few of them, particularly Ruth Kemenarm, Director of Health and Services and V. Ehert, R.N., Assistant Director of Health and Services, Michigan City Public Schools; Council for Health Education for Michigan City—President, P. Sprague; A. K. Smith, Superintendent, Michigan City Public Schools.

References

The Medical Teacher—His Responsibility
What, on the other hand, does it mean to teach medicine today? To squeeze the whole world of knowledge we possess; to extract what is fundamental, what is basic, limiting ourselves to the indispensable; to train a student in the complicated techniques of modern methods of study, educate his spirit to make a man of science out of him, wise in observation, aware in research, accurate in his reasoning, and all this without depriving him as a clinician, of the ability to apply his knowledge; achieve all this over a brief period of a few years, while the youth becomes a man, and then send him out into the world with an education and a mentality in harmony with our times—let us agree that this is a grand educational task, a fine challenge to the most optimistic teacher.—Dr. Ignacio Chávez. "Medical School and the Further Education of the Graduate Physician." A paper given in the University of Southern California before the members of Salerni Collegium, Universidad Nacional Autónoma De México, México, D.F., 1964, p. 5.
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Circulation. 1965;32:956-965
doi: 10.1161/01.CIR.32.6.956

Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 0009-7322. Online ISSN: 1524-4539

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