# Automated Multiphasic Health Testing

## *Diagnostic and testing results obtained at the Health Evaluation Center, Public Health Service Hospital, Baltimore*

BRYAN HOLLAND, MD, PETER M. HOLLAND, MD, and RICHARD K.C. HSIEH, DrPH

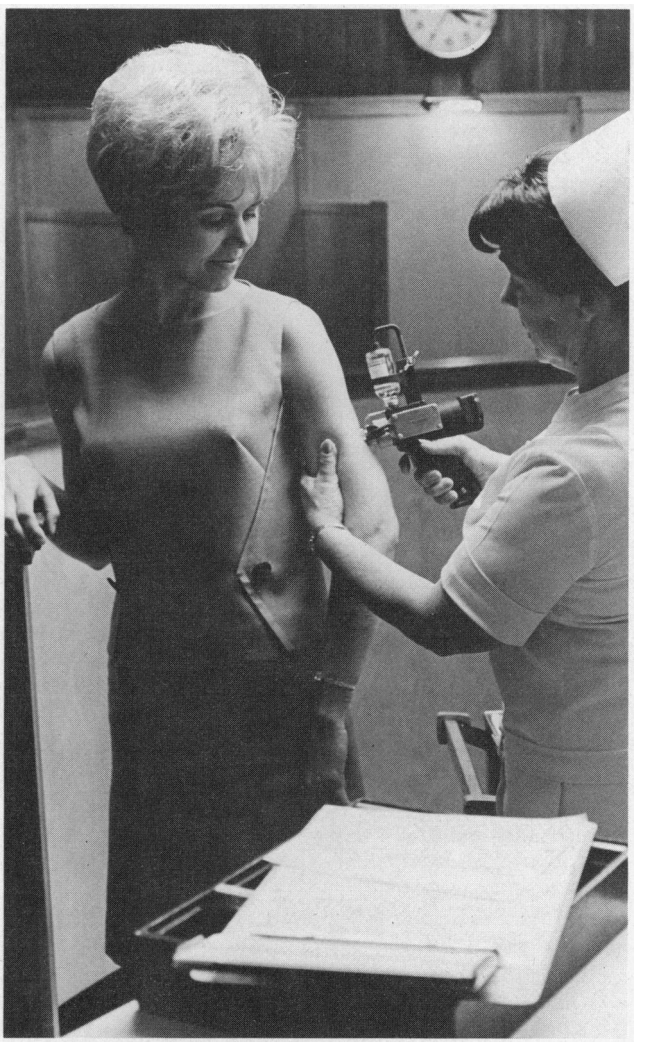
MULTIPHASIC HEALTH SCREENING was started in the mid-1940s as a public health technique for combining a variety of mass screening programs into a more economical and coordinated operation. Since that time, improved laboratory and computer technology have enabled a variety of other uses for the technique. The most notable success of automated multiphasic health testing (AMHT) has been in the Kaiser-Permanente system of comprehensive health care. Garfield *(1)* summarized the need for and uses of AMHT in a comprehensive health care system, and he proposed that only AMHT can solve the current health care crisis created by a discrepancy between the demands for medical care as a right and the ability of the health care system to meet these demands.

Because of the current clamor for changes in our health care delivery system with emphasis on comprehensive and preventive services, the promise that AMHT might provide the means to attain this goal, and the threat that widespread use of AMHT might deluge the system with patients who could not receive adequate followup care, the results of AMHT must be evaluated carefully.

In 1965 Roberts and Wylie *(2)* reported that although 2½ million persons in the United States had multiphasic screening tests in the past decade, little was learned about the value of the procedure because the emphasis was on persuading the public to take the tests rather than on studying the results. Reports of the Kaiser experience *(3–7)*, except the 1952 study *(3)*, do not distinguish between newly diagnosed and previously diagnosed conditions, nor do they include false positive or false negative results.

Early large-scale projects *(8)* were grossly deficient in determining diagnostic results because they depended on the erratic procedure of having a physician mail his diagnostic findings to the center where the patient had been tested. Obviously, busy physicians are not able to do this regularly enough so that meaningful data can be obtained. A more recent report *(9)* does not summarize the results in terms of abnormalities and diagnoses per patient, but rather only in terms of a particular test or diagnosis. Thus, one cannot predict what percentage of patients can be expected to have an abnormal condition. Also, false positive or false negative results are not reported.

The following study was undertaken to evaluate the results of multiphasic testing with special attention to diagnoses made by physicians and to false positive results, as well as to test results. The study group consisted of patients who were evaluated at the Health Evaluation Center (HEC), a multiphasic health testing facility at the Public Health Service Hospital in



*Dr. Bryan Holland, now at the University of Texas Southwestern Medical School, Dallas, and Dr. Peter M. Holland, now at the Duke University Medical Center, Durham, were with the Department of Health Services Research, Public Health Service Hospital, Baltimore, when this report was prepared. Dr. Hsieh is chief of the Health Services Research Branch at the Public Health Service Hospital. Tearsheet requests to Dr. R. K. C. Hsieh, Public Health Service Hospital, 3100 Wyman Park Drive, Baltimore, Md. 21211.*

Baltimore during an 8-month period—May 1970–January 1971. The operational aspects of the HEC have been detailed previously *(10)*. Briefly, after a patient receives the series of diagnostic tests, he is given a physical examination. All abnormal conditions are noted and, if necessary, the patient is entered into a primary care system.

HEC patients either request an appointment for routine physical examination or they are referred by the outpatient department for routine physical examination or for complete medical evaluation because of symptoms. The patients are sent a medical history questionnaire and three stool guaiac slides, with instructions for their preparation, before their appointment dates. When they arrive for their appointments, the questionnaires are checked for completeness and the slides are checked for proper preparation. From questionnaire responses, health testing results, physical examination, and further historical information, the physician can determine the patient's general state of health.

## Study Methods

A total of 1,199 patients received the AMHT during the 8-month period. All but 42 who had AMHT but did not return for physical examination were included in this study. The charts of the 1,157 patients were reviewed by two physicians (B.H. and P.M.H.) who had seen most of these patients. Diagnoses were coded according to the eighth revision ICDA *(11)*. Previously diagnosed and newly diagnosed conditions and false positive test results were recorded for each patient. Abnormal test results in most cases required confirmatory testing or followup in a specialty clinic before they were judged to be abnormal or false positive. Exceptions to this rule were *(a)* physical and dental examinations which were not feasible to repeat and *(b)* spirometry, for which the physician made a clinical judgment about the validity of the spirometry results and ordered a repeat study only if he considered it necessary. Each multiphasic testing category was classified as normal, not available, abnormal, false positive, or abnormal with no followup.

At the HEC, the following are considered to be abnormal test values:

***Weight:*** more than 1 standard deviation above or 2 standard deviations below the smoothed average weight corrected for age, sex, and height, as established by the National Health Survey *(12)*.

***Blood pressure:*** 150/90 mm Hg or greater.

***Oral temperature:*** 100°F or higher.

***Audiometry with Beltone audiometer:*** a loss in either ear of greater than 25 decibels for an average frequency of 500, 1,000, and 2,000 cycles per second or equal to or greater than the patient's age in decibels for a frequency of 4,000 cycles per second.

***Spirometry with the Collins spirometer:*** any one of the following—
A vital capacity less than the predicted value established by the normograms of Kory and associates *(13,14)*.
A $FEV_{1.0}$ (1.0 second forced expiratory volume) per predicted $FEV_{1.0}$ of less than 80 percent.
A timed vital capacity of less than 75 percent.
A forced expiratory flow (FEF) of 200–1,200 ml or 25–75 percent as follows:

| *Age group (years)* | *Liters per second* |
|---|---|
| | $FEF_{200-1,200}$ |
| Under 40 | 5.2 |
| 40–59 | 3.6 |
| Over 59 | 2.6 |
| | $FEF_{25-75\%}$ |
| Under 30 | 2.8 |
| 30–39 | 2.3 |
| 40–59 | 1.8 |
| Over 59 | 1.0 |

***Vision testing with the Titmus tester:*** distant acuity of 20/30 or worse; near acuity of 14/35 or worse; or defective color vision denoted by incorrect reading of more than 3 of 8 digits.

***Schiotz tonometry:*** a pressure in either eye of 23 mm Hg or greater or a difference between eyes of 5 mm Hg or greater.

***Visual field testing with the Harrington-Flocks screener:*** any point defect.

***Blood chemistry with the SMA–12:*** exceeding any of the following ranges—

| | |
|---|---|
| Calcium | 9.0–11.3 mg per 100 ml |
| Phosphorus | 2.6–4.9 mg per 100 ml |
| BUN (urea nitrogen) | 4–22 mg per 100 ml |
| Uric acid: | |
| Males | 0–8.4 mg per 100 ml |
| Females | 0–6.8 mg per 100 ml |
| Cholesterol | 120–300 mg per 100 ml |
| Total protein | 6.4–8.5 gm per 100 ml |
| Albumin | 3.8–6.0 gm per 100 ml |
| Bilirubin | 0–1.2 mg per 100 ml |
| Alkaline phosphatase | 0–100 mIU |
| LDH (lactic dehydrogenase) | 0–230 mIU |
| SGOT (serum glutamic oxaloacetic transaminase) | 0–62 units per ml |
| Glucose (1 hour post Dexacola equivalent to 75 gm glucose load): | |
| If patient has eaten in past 3 hours— | |
| Under 30 years old, up to | 210 mg per 100 ml |
| 31–39 years | 220 mg per 100 ml |
| 40–49 years | 235 mg per 100 ml |
| 50 years or older | 240 mg per 100 ml |
| If patient has eaten 4 or more hours ago, up to | 230 + 0.66 mg per 100 ml X age |

***Urinalysis:*** presence of any of the following—
Glucose, protein, ketones, or blood
More than 3 white blood cells per high-power field (WBC/HPF) for males or 5 WBC/HPF for females
Clumps of WBC/HPF or glitter cells present
More than 2 RBC/HPF for males or 3 RBC/HPF for females
More than an occasional hyaline cast or presence of any other type of cast
More than a small number of yeast cells or bacteria
Trichomonads

***Complete blood count:*** exceeding any of the following ranges—

| | |
|---|---|
| Hemoglobin: | |
| Females | 12.0–15.0 gm per 100 ml |
| Males | 13.0–16.7 gm per 100 ml |
| Hematocrit: | |
| Females | 37–57 percent |
| Males | 40–54 percent |
| White blood cells | 4,000–12,000 per cu mm |

*VDRL (reactive plasma reagin card test) for syphilis:* reactive in any dilution.

*Stool guaiac test (for occult blood):* any of three samples weakly positive or positive.

*Psychological (modified Minnesota Multiphasic Personality Inventory):*
(*a*) 6 or more scales with a "T" score of more than 70 or (*b*) "T" score of more than 80 for depression, paranoia, schizophrenia, or mania.

*Papanicolaou smear:* class 2 to 4.

*Physical and dental examinations, electrocardiogram, and chest X-ray:* abnormal by usual clinical criteria.

**Table 1. Age-sex distribution of 1,157 patients who received automated multiphasic health testing at Health Evaluation Center, Public Health Service hospital, Baltimore**

| Age group (years) | Percent of total | | |
|---|---|---|---|
| | Male | Female | Total |
| 10–19 | 1 | 1 | 1 |
| 20–29 | 12 | 22 | 18 |
| 30–39 | 9 | 20 | 16 |
| 40–49 | 27 | 25 | 26 |
| 50–59 | 33 | 20 | 25 |
| 60–69 | 11 | 7 | 9 |
| 70–79 | 5 | 4 | 4 |
| 80–89 | 0 | 1 | 0 |
| Total | 40 | 60 | 100 |

## Results

The age and sex distribution of the 1,157 study patients is shown in table 1. Beneficiary status, geographic location, family income, and occupations of this population have been reported in detail previously (*15*). In brief, about 57 percent were retired or active members of the uniformed services or American seamen, and the remainder were dependents of the uniformed service personnel. More than 87 percent of the patients lived in the metropolitan Baltimore area. About 47 percent had a yearly family income of less than $10,000; 25 percent, $10,000–$14,999; and 19 percent, $15,000 or more (income not known for 9 percent). A variety of occupations was reported by the study population; the most frequent categories were professional and technical, housewife, and clerical. According to their medical history questionnaires, 78 percent of the patients had no work-limiting conditions, 20 percent had some limitation, and 2 percent were unable to work.

The initial multiphasic test results and followup evaluation of abnormal results are shown in table 2. The number of people in each test category varies for several reasons; for example, temporary malfunction of equipment, patient's refusal to take a test, no X-rays taken because of possible pregnancy, faulty recording of test results by a technician, or failure of a patient to return the stool guaiac specimens. The tests are listed in order of decreasing percentage of abnormal results for the initial testing categories. Of the initial tests, the physical and dental examinations, vision testing, spirometry, and audiometry yielded the greatest number of abnormalities. The five categories with the highest percentage of false positive results were tonometry, visual fields, urinalysis, Papanicolaou smear, and blood chemistry.

Examination of the confirmed abnormal results after followup revealed that for several testing categories a notable change occurred as a result of elimination of false positives and abnormal results that were not followed up. Vision abnormalities decreased from 44 to 22 percent; spirometry from 31 to 22 percent;

**Table 2. Results of automated multiphasic health testing, Health Evaluation Center**

| Test category | Initial testing | | | Followup of abnormal results | | | | |
|---|---|---|---|---|---|---|---|---|
| | Number patients tested | Abnormal | | Number followed up[1] | False positive | | Confirmed abnormal | |
| | | Number | Percent | | Number | Percent[2] | Number | Percent[3] |
| Dental | 1,149 | 901 | 78.4 | .... | .... | .... | .... | .... |
| Physical | 1,157 | 725 | 62.7 | .... | .... | .... | .... | .... |
| Vision | 1,098 | 488 | 44.4 | 378 | 118 | 31.6 | 260 | [4]23.7 |
| Spirometry | 1,078 | 332 | 30.8 | 329 | 93 | 28.3 | 236 | 21.9 |
| Audiometry | 1,153 | 332 | 28.8 | 263 | 52 | 19.8 | 211 | [4]18.3 |
| Blood chemistry (SMA-12) | 1,135 | 273 | 24.1 | 264 | 89 | 33.7 | 175 | 15.4 |
| Weight | 1,155 | 246 | 21.3 | 246 | 0 | 0 | 246 | 21.3 |
| Urinalysis | 1,138 | 221 | 19.4 | 213 | 97 | 45.5 | 116 | 10.2 |
| Blood pressure | 1,155 | 184 | 15.9 | 184 | 12 | 6.5 | 172 | 14.9 |
| Chest X-ray | 1,123 | 178 | 15.9 | 178 | 14 | 7.9 | 164 | 14.6 |
| Electrocardiogram | 1,149 | 144 | 12.5 | 144 | 1 | .7 | 143 | 12.4 |
| Psychological | 1,095 | 96 | 8.8 | 90 | 4 | 4.4 | 86 | 7.9 |
| Complete blood count | 1,151 | 100 | 8.7 | 93 | 20 | 19.4 | 73 | 6.3 |
| Visual fields | 1,035 | 58 | 5.6 | 51 | 26 | 51.0 | 25 | [4]2.4 |
| Tonometry | 986 | 31 | 3.1 | 28 | 26 | 92.9 | 2 | .2 |
| Papanicolaou smear | 600 | 15 | 2.5 | 15 | 6 | 40.0 | 9 | 1.5 |
| Stool blood (guaiac) | 1,081 | 17 | 1.6 | 12 | 1 | 8.3 | 11 | [4]1.0 |
| VDRL test for syphilis | 1,149 | 15 | 1.3 | 14 | 3 | 21.4 | 11 | 1.0 |
| Oral temperature | 1,154 | 2 | .2 | 2 | 0 | 0 | 2 | .2 |

[1]Number of patients with abnormal results for which followup testing could be obtained.
[2]False positive x 100 per abnormal followed up.
[3]Confirmed abnormal x 100 per number tested.
[4]Followup less than 90 percent.

audiometry from 29 to 18 percent; blood chemistry from 24 to 15 percent; urinalysis from 19 to 10 percent; and tonometry from 3.1 to 0.2 percent. The small percentage decrease for tonometry compared with the false positive rate of 93 percent simply reflects the small number of patients who had abnormal tonometry results. For most of the test categories, any change in percentage of abnormalities reflects elimination of false positive results.

Initial abnormal results that could not be confirmed as such were eliminated from the calculations. In the vision testing, for example, 448 of 1,098 patients had initial abnormal results; 378 of these patients were followed up and 260 were confirmed to have abnormal vision. Thus, a true percentage of abnormal results cannot be obtained because not all 448 patients were followed up, and the confirmed abnormal rate of 24 percent (260 x 100 per 1,098) is falsely low because it assumes that none of the 70 patients with initial abnormal results and no followup had abnormal vision.

For all but four test categories, however, the followup rate was more than 90 percent; thus, elimination of initial abnormal results without followup is inconsequential. In categories with more than 90 percent followup, the change in percentage of abnormal results can be considered to be essentially a result of elimination of false positives. The followup rates for the four categories with less than 90 percent were 85 percent for vision testing, 79 percent for audiometry, 88 percent for visual fields, and 71 percent for stool blood. The confirmed abnormal rates for these four categories were affected to a greater extent than those of the other categories by elimination of unconfirmed abnormal test results. If compensation is made for the four categories by the assumption that the false positive rate for each category would remain the same for the unconfirmed abnormal results, as was found for the abnormal results that were followed up, then we could predict that the abnormal percentages would be 31 instead of 24 for vision testing, 23 instead of 18 for audiometry, 2.8 instead of 2.4 for visual fields, and 1.4 instead of 1.0 for stool blood.

The diagnostic results are presented in tables 3 and 4. Table 3 shows the 20 most common newly diagnosed and previously diagnosed conditions and their frequency among the study patients. The diagnoses listed are only those abnormalities which were confirmed, with the exception of dental abnormalities. The dental abnormalities were mostly caries and periodontal disease and were not subdivided; previously diagnosed abnormalities are not listed. Refractive errors, listed only under new diagnoses, represent all newly discovered refractive errors and all instances in which a patient's lenses did not correct his vision. The refractive errors that were adequately corrected are not listed. All cases of exogenous obesity were considered to be previous diagnoses. Hearing loss is primarily neurosensory; a few cases of otosclerosis are included. Hyperlipidemia includes hypercholesterolemia and hypertriglyceridemia with or without evidence of cardiovascular disease. Hyperuricemia and gout include cases of asymptomatic hyperuricemia, classic gout, and symptomatic hyperuricemia for which differentiation between gout and osteoarthritis was difficult. Medication-induced hyperuricemia is not included.

The five most common newly diagnosed conditions were dental abnormalities, refractive error, neurosis, chronic obstructive pulmonary disease, and hearing loss. The five most common previously diagnosed conditions were exogenous obesity, essential hypertension, hearing loss, neurosis, and arteriosclerotic cardiovascular disease.

The frequency of diagnoses, classified according to the ICDA *(11)*, is shown in table 4. The results are expressed as frequency per 1,000 patients for newly and previously diagnosed conditions. The high frequency of dental abnormalities is reflected in "Diseases of digestive system." Hearing loss and refractive error are included in "Diseases of nervous system and sense organs," and exogenous obesity is included in "En-

**Table 3. Diagnostic results among 1,157 patients at Health Evaluation Center, by frequency of 20 most common diagnoses**

| *New diagnoses* | *Percent* | *Old diagnoses* | *Percent* |
|---|---|---|---|
| 1. Dental abnormalities | 78.4 | Exogenous obesity | 21.3 |
| 2. Refractive error | 21.5 | Essential hypertension | 7.0 |
| 3. Neurosis | 19.4 | Hearing loss | 5.6 |
| 4. Chronic obstructive pulmonary disease | 14.8 | Neurosis | 6.3 |
| 5. Hearing loss | 14.1 | Arteriosclerotic cardiovascular disease | 3.2 |
| 6. Essential hypertension | 7.9 | Osteoarthritis | 2.7 |
| 7. Vaginitis | 6.6 | Hypertensive cardiovascular disease | 2.5 |
| 8. Diabetes mellitus | 3.6 | Diabetes mellitus | 2.5 |
| 9. Arteriosclerotic cardiovascular disease | 3.4 | Peptic ulcer disease | 1.7 |
| 10. Hyperlipidemia | 3.4 | Fibrocystic breast disease | 1.7 |
| 11. Osteoarthritis | 3.2 | Asthma | 1.6 |
| 12. Cervicitis | 2.8 | Hemorrhoids | 1.6 |
| 13. Benign prostatic hypertrophy | 2.7 | Glaucoma | 1.2 |
| 14. Hyperuricemia and gout | 2.3 | Chronic obstructive pulmonary disease | 1.0 |
| 15. Iron deficiency anemia | 2.2 | Hyperuricemia and gout | .9 |
| 16. Hemorrhoids | 1.8 | Hyperlipidemia | .9 |
| 17. Fibrocystic breast disease | 1.6 | Chronic sinusitis | .9 |
| 18. Pelvic relaxation | 1.6 | Allergic rhinitis | .9 |
| 19. Alcoholic cirrhosis | 1.4 | Hypothyroidism | .9 |
| 20. Urinary tract infection | 1.3 | Migraine headache | .9 |

**Table 4. Frequency distribution of new and old diagnoses, by Eighth Revision ICDA classification, among Health Evaluation Center patients.**

| | ICDA Classification | Number per 1,000 patients | |
|---|---|---|---|
| | | New | Old |
| I. | Infective and parasitic diseases | 84 | 14 |
| II. | Neoplasms | 35 | 11 |
| III. | Endocrine, nutritional, and metabolic diseases | 107 | 281 |
| IV. | Diseases of blood and blood-forming organs | 50 | 5 |
| V. | Mental disorders | 218 | 84 |
| VI. | Diseases of nervous system and sense organs | 381 | 113 |
| VII. | Diseases of circulatory system | 235 | 182 |
| VIII. | Diseases of respiratory system | 183 | 55 |
| IX. | Diseases of digestive system | 800 | 41 |
| X. | Diseases of genitourinary system | 142 | 61 |
| XI. | Complications of pregnancy and puerperium | 0 | 0.9 |
| XII. | Diseases of skin and subcutaneous tissue | 40 | 18 |
| XIII. | Diseases of musculoskeletal system and connective tissue | 42 | 38 |
| XIV. | Congenital anomalies | 13 | 15 |
| XV. | Certain causes of perinatal morbidity and mortality | 0 | 0 |
| XVI. | Symptoms and ill-defined conditions | 20 | 10 |
| XVII. | Accidents, poisonings, and violence | 7 | 3 |
| Special conditions and examinations without sickness | | 10 | 10 |

docrine, nutritional, and metabolic diseases." Examples of "Special conditions and examinations without sickness" are pregnancy, tuberculosis skin test converters, and biologic false positive serologic tests for syphilis.

Table 5 summarizes the AMHT and followup results. Various categories have been excluded to demonstrate the changes in the frequency of both testing and diagnostic abnormalities. The exclusion of dental examination, physical examination, and Papanicolaou smear provides some indication of the results that can be obtained at the testing center without the aid of other dentists or physicians. The exclusion of false positive and no followup results gives a better picture of the true percentages. Exclusion of dental, vision, and hearing abnormalities from the diagnostic results eliminates what some professionals might consider to be diagnoses of lesser consequence, although these categories would be of utmost importance to the patient. Thirty-six percent of our patients had at least one false positive test result. This percentage would be somewhat higher with complete followup of all patients.

## Discussion

Our study results indicate that the AMHT is an efficient and productive technique for evaluation of patients. Bates and Yellin *(16)*, however, reported finding a low prevalence of disease. This discrepancy is readily explained by the failure of Bates and Yellin to perform traditional tests such as chest X-ray, EKG, urinalysis, blood pressure, visual acuity, BUN, VDRL test for syphilis, and physical examination.

We sent questionnaires to the HEC study patients after they had been tested, and their responses were almost unanimously favorable regarding the AMHT. The patients did not complain of a feeling of "assembly line" medicine, rather they appreciated the way in which the system is organized to allow them to receive extensive testing in about 1½ hours. About 30 minutes of physician time are usually required for complete physical examination, review of the testing results and the medical history questionnaire with the patient, summarization of the results in a problem-oriented format, ordering of additional tests or specialty evaluations, and initiation of needed therapy. All followup visits are to the same physician, except for care during emergency hours. Many patients com-

**Table 5. Summary of automated multiphasic health testing (AMHT) and followup results at the Health Evaluation Center**

| Results | Number of patients (N=1,157) | Percent of total |
|---|---|---|
| AMHT only | | |
| At least 1 abnormal result | 1,132 | 98 |
| Excluding dental | 1,061 | 92 |
| Excluding dental, physical, and Papanicolaou smear | 989 | 85 |
| Excluding false positive and no followup | 1,119 | 97 |
| Excluding false positive, no followup,and dental | 979 | 85 |
| Excluding false positive, no followup,dental, physical, and Papanicolaou smear | 850 | 74 |
| Followup[1] | | |
| At least 1 new diagnosis | 1,101 | 95 |
| Excluding dental | 898 | 78 |
| Excluding dental, vision, and hearing | 809 | 70 |
| At least 1 old diagnosis | 639 | 55 |
| No new or old diagnoses | 30 | 3 |
| Excluding dental, vision, and hearing | 165 | 14 |
| At least 1 false positive | 420 | 36 |

[1]New diagnoses totaled 2,689; old diagnoses totaled 1,086.

mented that the AMHT has made it easier for them to obtain a yearly health checkup, which in turn contributes to a sense of health consciousness.

We have found AMHT to be ideal for use in circumstances such as the following:

1. Evaluation of the asymptomatic patient to determine the state of health, detect occult disease, and serve as the entry point into a comprehensive health care system.
2. Evaluation of the symptomatic patient in a rapid but comprehensive fashion.
3. Initial hospital evaluation of certain types of elective-admission patients (results for these patients are not included in the present study).
4. Periodic followup of patients with certain known chronic diseases.

Thus, limitation of AMHT to the function of mass screening of asymptomatic patients is unfortunate. Quality evaluation of patients can be provided with a minimum of physician and patient time. AMHT is the ideal entry point into a comprehensive health care system.

Despite the advantages of AMHT, however, there are possible pitfalls in its widespread adoption. Careful consideration must given to the comprehensive health care system. Disease dectection by AMHT is quite fruitful. Among our patients, 95 percent had at least one newly diagnosed condition. Undoubtedly, our patients are not typical of the general American population. As pointed out earlier, 78 percent had no condition that limited their ability to work, 20 percent had some limitation, and 2 percent were unable to work.

After the study population was evaluated, the medical questionnaire was revised to include the reason for a patient's visit to the HEC. Among the population that immediately followed the study patients, 40 percent came for routine evaluation and considered themselves asymptomatic, 40 percent came for evaluation of symptoms, and 20 percent had been referred by the outpatient department for more comprehensive evaluation. We assume that approximately the same percentages held for the study patients.

This study might be criticized for the inclusion of patients who were symptomatic, since the percentage of such persons would obviously influence the frequency of testing and diagnostic abnormalities. However, it must be remembered that approximately one-third of the HEC patients are under 40 years old, and the importance of periodic physical examinations is well engrained in this basically military population of the Public Health Service facility. Therefore, we do not consider the HEC patients to be an unusually ill population.

Moreover, the purpose of the study was not to detect diseases or conditions in asymptomatic persons. Rather, the Public Health Service system provides free medical care and encourages periodic physical examinations. Since the American population is composed of both symptomatic and asymptomatic persons, the results obtained from examination of asymptomatic persons or a strict cross section of the population is of limited importance. More important is the question: What are the frequency and types of abnormalities seen when people respond to an invitation for a free, complete checkup? The answer to this question is important when any type of comprehensive health care system, whether private or governmental, is being planned.

According to Collen *(5)*, about 60 percent of the Kaiser-Permanente patients have at least one important clinical abnormality. However, Collen's report does not distinguish between newly diagnosed and chronic abnormalities, does not include dental abnormalities, and does not give the percentage of symptomatic patients. Therefore, it is difficult to compare the Kaiser population with ours. If we exclude our patients with dental abnormalities, the percentage with at least one new diagnosis falls to 78 percent.

Thus, although modern AMHT attains a significant yield of persons with abnormal results, this yield necessitates careful planning of a comprehensive health care system for each multiphasic testing center. In many areas, the supply of physicians and paramedical personnel may well be a critical problem. Additionally, the following factors also require careful attention:

- Practical clinical decisions about the number of tests provided, the frequency of testing, and the normal values to be used to minimize false positive and false negative results.
- Strict quality control over equipment used and technician performance.
- Provision of an excellent feedback system for the clinicians using the multiphasic testing center to assist in quality control, physicians' understanding of test results, and clinical decisions about false positive and false negative results, frequency of testing, tests provided, content of medical history questionnaire, and format of medical report.

The problem of false positive test results is emphasized by the false positive rate of 36 percent among our study patients. It is our hope that this rate can be reduced with further experience. If the physician has good communication with the AMHT center, he can soon appreciate minor false positive results and thereby diminish their significance.

The financial aspects of AMHT will require careful planning before widespread adoption. Collen and associates *(7)* reported that the cost is potentially quite reasonable on a per patient basis but that patient load is the critical factor which influences cost. It is obvious that widespread adoption of AMHT will be costly. Careful planning will be needed to insure that AMHT centers will have large patient populations for economical operation. In addition, careful cost analysis of each component of AMHT must be combined with considerations of the health care needs and resources of the target population and the usefulness of each particular test for that population. It is again useful when considering the cost of AMHT to remember its uses for the rapid, complete evaluation of the symptomatic patient and the periodic re-evaluation of the patient with known chronic disease. In low income pop-

ulations, which are known to be refractory to preventive health programs, these uses may be more successful economically than attempts at mass screening of basically asymptomatic persons.

Thus, AMHT is a highly efficient and rewarding mechanism for detection of disease. As Garfield *(1)* noted, it offers the promise of being a key factor in the fulfillment of demands created by the concept of medical care as a right. It is hoped that careful study of the results obtained from AMHT will guide future decisions as to the impact of its adoption.

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# SYNOPSIS


**HOLLAND, BRYAN (University of Texas Southwestern Medical School, Dallas), HOLLAND, PETER M., and HSIEH, RICHARD K.C.:** *Automated multiphasic health testing. Diagnostic and testing results obtained at the Health Evaluation Center, Public Health Service Hospital, Baltimore. Public Health Reports, Vol. 90, March-April 1975, pp 133–139.*

The results of automated multiphasic health testing (AMHT) were evaluated with special attention to diagnoses made by physicians and to false positive results, as well as to laboratory test results. The study population consisted of 1,157 patients at the Health Evaluation Center of the Public Health Service Hospital in Baltimore.

Although 95 percent of the patients had at least one newly diagnosed disease or condition, the percentage dropped to 78 percent when dental abnormalities were excluded and to 70 percent when dental, vision, and hearing abnormalities were excluded. Abnormal laboratory test results were observed for 98 percent of the patients, and 36 percent had at least one false positive test result.

The study results indicated that AMHT is a highly productive method for comprehensive medical testing with a variety of uses other than mass screening. The productive diagnostic yield combined with a high percentage of false positive results dictate the need for careful planning for followup care, strict attention to quality control, and excellent communication between the AMHT center and the practicing physician.