An Evaluation of Enteric Parasitology Performed in State Laboratories

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DURING the past several years the Association of State and Territorial Health Officers, the Conference of State and Provincial Public Health Laboratory Directors, and the National Advisory Health Council have requested the Public Health Service through the Communicable Disease Center to evaluate the proficiency of State public health laboratories in the performance of various diagnostic procedures. The value of this type of program in stimulating improvement of laboratory proficiency has long been demonstrated in the field of syphilis serology (*1*).

In response to these requests, the Communicable Disease Center established a mechanism for evaluating the performance of public health laboratories in the detection and identification of *Endamoeba histolytica* and other intestinal parasites. The objective of the evaluation was to obtain information whereby the State and Territorial laboratories could compare, anonymously, their diagnostic efficiency. With this basic information, deficiencies might be recognized and self-improvement undertaken.

In June 1949, each of the laboratories of State and Territorial health departments were invited to participate in the evaluation. The following 38 State and 4 Territorial laboratories asked to be included in the program:

Arizona, Arkansas, California, Connecticut, Florida, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Montana, Nebraska, Nevada, New Jersey, New York, North Carolina, North Dakota, Ohio, Oregon, Pennsylvania, South Carolina, Tennessee, Texas, Utah, Vermont, Virginia, Washington, West Virginia, Wisconsin, Alaska, Canal Zone, Hawaii, Puerto Rico.

The American Society of Tropical Medicine upon request selected three laboratories to serve as referees. The referee laboratories were under the direction of the following authorities:

Dr. William W. Frye, Louisiana State University School of Medicine, New Orleans; Dr. Herbert G. Johnstone, University of California Medical School, San Francisco; and Dr. W. G. Sawitz, Jefferson Medical College, Philadelphia. (Dr. E. C. Faust, Tulane University School of Medicine, New Orleans, was appointed as a substitute referee during 2 months of the evaluation.)

Specimens

The stool specimens used in the evaluation were obtained from various individuals, some harboring no organisms, and others having one or more species of intestinal parasites. All of the specimens were obtained without catharsis or proctoscopy, and 75 percent of them were formed in consistency. They were sent to the participating laboratories as unpreserved stool specimens, formalin-preserved specimens, stool specimens preserved in PVA-fixative (*2*), or as stained fecal smears with or without prior preservation in PVA-fixative. Table 1 presents the number of each type in the 110 specimens distributed, the types in the 98 included in the official key, and those containing *E. histolytica*.

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Of the 12 specimens excluded from the evaluation 11 were unpreserved specimens; the other was a stool preserved in PVA-fixative.

Table 1. Types of specimens distributed to participating laboratories and referees during the parasitological evaluation program

Types of specimens	Total number distributed	Number in official key	Number in key with *E. histolytica*
Stools in vials:			
Unpreserved	55	44	3
In formalin	45	45	13
In PVA-fixative	4	3	1
Stained fecal smears	3	3	0
Stained fecal smears in PVA-fixative	3	3	1
Total	110	98	18

The 110 specimens were mailed in 11 equal shipments between July 1949 and June 1950. Various postal methods were used in order that the specimens of a given shipment might arrive at the laboratories on approximately the same date. Of 4,950 specimens shipped, only 7 arrived in a damaged condition. The report form which accompanied the specimens gave information on the type and collection of specimen on one side, and on the other provided space for recording the condition of the specimen upon arrival, the examination techniques used by the participating laboratories, and the names of the organisms found. At the bottom of the report was space for the signature of the director and the name of the participating laboratory. Duplicate report forms were provided in order that the laboratories might maintain independent records. (Copies of the form are available from the authors upon request.)

Each participating laboratory and referee was given a code number, known only to the laboratory involved and to certain individuals within the Communicable Disease Center. When the reports were received at CDC, the code number of the laboratory was written on each side of the report. The signature of the director was then detached and put in a separate file to protect the identity of all records.

Official Key to Identification

Portions of the specimens were sent to the three referees on the same day they were distributed to the participating laboratories. In addition, specimens were mailed to a neighboring State and returned to Atlanta for examination by the parasitology laboratories of the Communicable Disease Center. The three referees and CDC agreed on the presence or absence of *E. histolytica* in 91 specimens. In 7 other specimens, two of the referees and CDC reported the presence of *E. histolytica*. Therefore, in 98 specimens out of 110 distributed, the presence or absence of *E. histolytica* was confirmed by at least two referees and CDC. The 12 other specimens were excluded from the evaluation since only one referee and/or CDC reported the presence of *E. histolytica*.

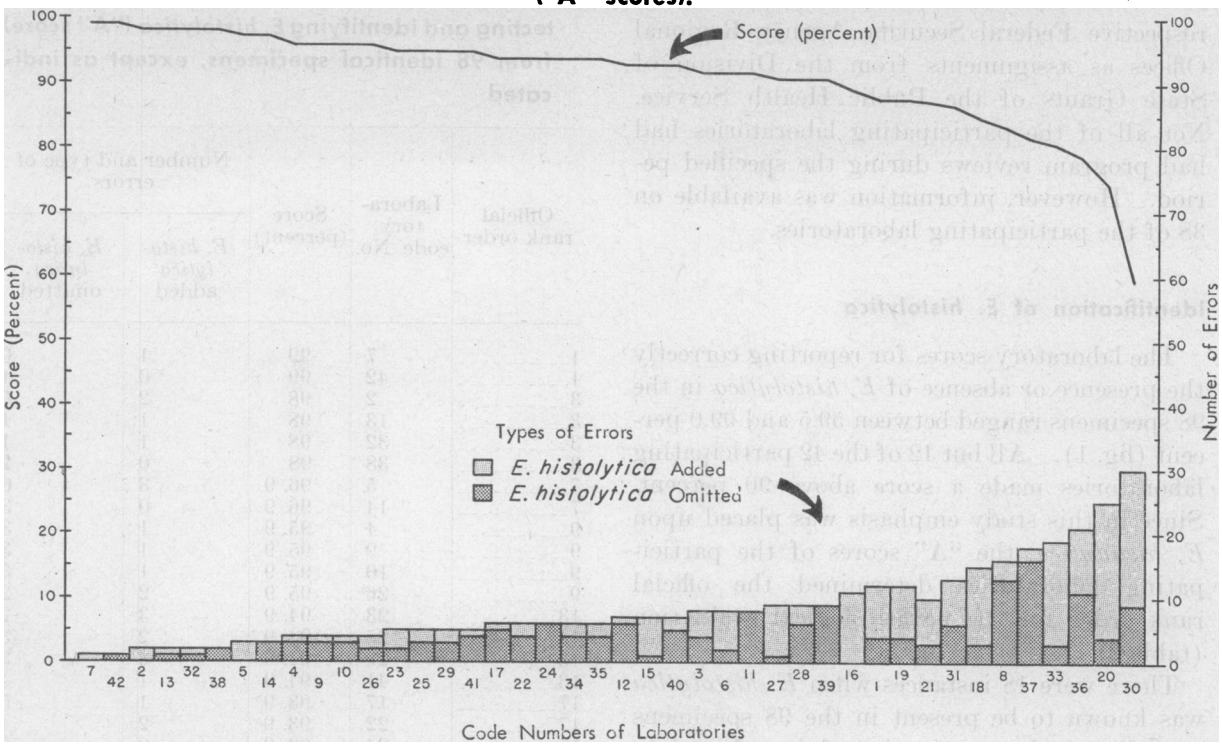
Other organisms were included in the official key to the 98 specimens if at least two of the three referees reported them. If only one referee and/or CDC reported a given organism (exclusive of *E. histolytica*), the organism was placed in the official key in parentheses. In scoring the reports, the participating laboratories were given credit if they found the additional organisms, but they were not penalized for failing to find them. The complete official key to the 98 specimens has been published elsewhere (*3*).

Scoring of Reports

The official key was used to check the errors and omissions of the laboratories in reporting organisms. The scores of the laboratories were determined on the basis of the number of the 98 specimens examined. Three laboratories, 8, 21, and 30, were scored on the basis of 97, 79, and 74 specimens, respectively. For each specimen, the reporting laboratory received two principal scores, "A" and "B."

"A" Score (E. histolytica). In compiling the "A" score, only *E. histolytica* was considered. A unit value was given whenever the presence or absence of *E. histolytica* was reported correctly. The total score of each laboratory was converted to a percentage of the maximum score possible for the number of specimens examined.

Figure 1. Proficiency of participating laboratories in detecting and identifying *E. histolytica* ("A" scores).



"B" Score (all organisms). All organisms, including *E. histolytica*, were considered in determining this score. If the laboratory reported all of the organisms found by two or more referees and did not report any organisms not reported by any referee, it received the maximum score of 10 for the specimen. Misdiagnoses, omissions, and additions of organisms were given numerical values and were subtracted from the maximum possible score for each specimen. The resulting scores were converted to percentages.

All of the information on the specimens (examination procedures, organisms reported, and the scores, as well as the supplementary information mentioned below) was recorded on IBM cards for tabulation.

Supplementary Information

As much information as possible about the participating laboratories was obtained for use in interpreting the results. Information was available from two main sources—a questionnaire distributed during the evaluation program and the records of the laboratory consultation services of the Communicable Disease Center.

The questionnaire on the laboratory examination of stool specimens for parasites requested the participating laboratories to furnish information on the volume of parasitological work, the type and condition of specimens examined, the type and frequency of techniques used, and the technical training of laboratory personnel performing the examinations. Forty-one of the laboratories returned the completed questionnaire. The code numbers of the laboratories were written on the questionnaires in order that they might be filed anonymously after the signatures of the directors had been detached.

Statistical information pertaining to the technician workload and the financial status of the laboratories was obtained from the files of the office of the laboratory consultation services. The information in these files has been collected by CDC staff members or consultants in the course of conducting program reviews of the laboratory facilities of the State departments of health. The information used was collected just prior, during, or immediately following

the period of the evaluation. These program reviews are conducted under the auspices of the respective Federal Security Agency Regional Offices as assignments from the Division of State Grants of the Public Health Service. Not all of the participating laboratories had had program reviews during the specified period. However, information was available on 38 of the participating laboratories.

Identification of *E. histolytica*

The laboratory scores for reporting correctly the presence or absence of *E. histolytica* in the 98 specimens ranged between 59.5 and 99.0 percent (fig. 1). All but 12 of the 42 participating laboratories made a score above 90 percent. Since in this study emphasis was placed upon *E. histolytica*, the "A" scores of the participating laboratories determined the official rank order for the parasitological evaluation (table 2).

There were 18 instances when *E. histolytica* was known to be present in the 98 specimens according to the examination of the referee laboratories. Four of the participating laboratories found all 18, while other laboratories missed from 1 to 16 of these positives. On an average, *E. histolytica* was missed 4.1 times by the laboratories.

In 80 specimens *E. histolytica* was reported absent by the referee laboratories. Six of the participating laboratories did not report any false positive diagnoses of *E. histolytica;* the remaining laboratories reported it to be present in from 1 to 21 of the 80 specimens. On an average, the 42 laboratories added *E. histolytica* 4.4 times when it was known to be absent according to the reports of the referees.

Identification of All Species

In addition to *E. histolytica*, 14 other species of organisms were found in the 98 specimens by the referees and CDC (table 3). Of the 98 specimens, 74 were reported positive by the referees and contained a total of 149 species infections. No organisms were found by the referees in 24 specimens.

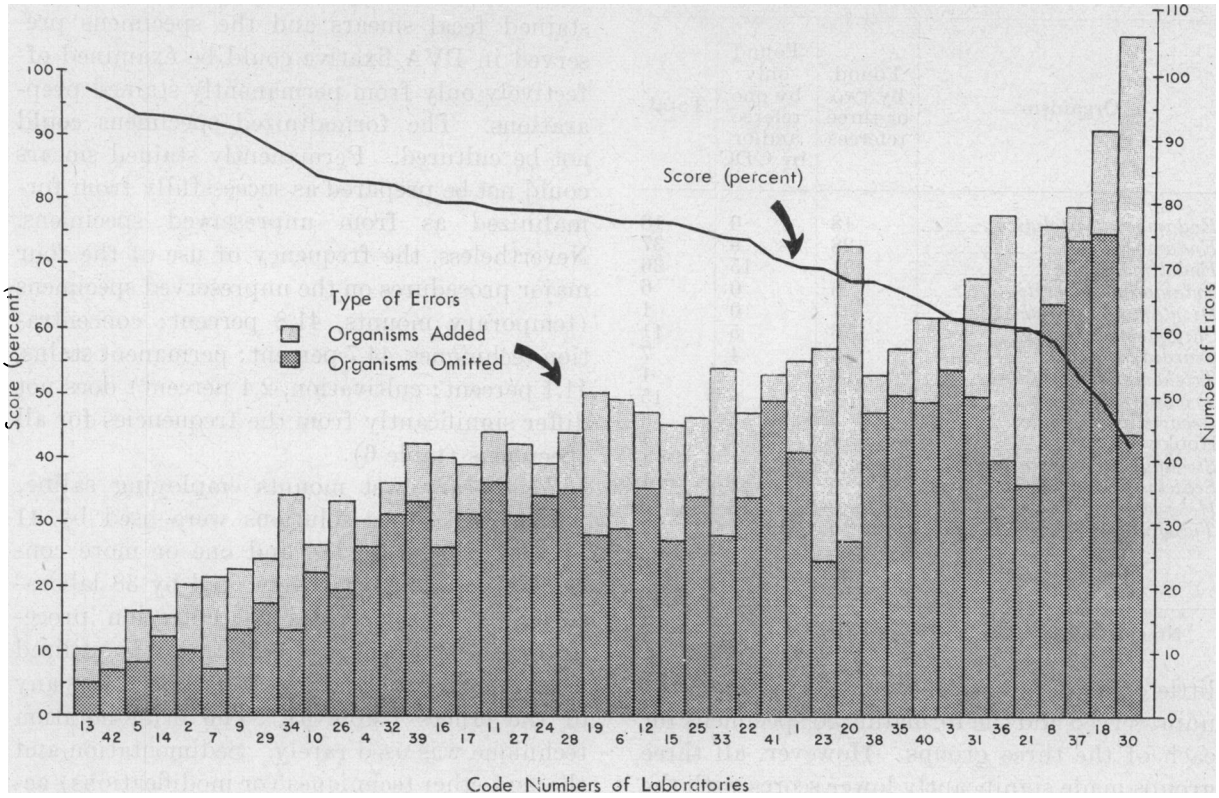
As described previously, the "B" scores were obtained by considering all of the organisms reported to be present. The "B" scores of the participating laboratories ranged between 42.0 and 97.1 percent (fig. 2). In 600 instances organisms were reported by the participating laboratories when they were not recorded on the official key. The number of added organisms ranged from 3 to 62, with an average of 14.3 per laboratory.

Table 2. Official rank order of participating laboratories as determined by scores made in detecting and identifying *E. histolytica* ("A" score) from 98 identical specimens, except as indicated

Official rank order	Laboratory code No.	Score (percent)	Number and type of errors	
			E. histolytica added	*E. histolytica* omitted
1	7	99	1	0
1	42	99	0	1
3	2	98	2	0
3	13	98	1	1
3	32	98	1	1
3	38	98	0	2
7	5	96.9	3	0
7	14	96.9	0	3
9	4	95.9	1	3
9	9	95.9	1	3
9	10	95.9	1	3
9	26	95.9	2	2
13	23	94.9	3	2
13	25	94.9	2	3
13	29	94.9	2	3
13	41	94.9	1	4
17	17	93.9	1	5
17	22	93.9	2	4
17	24	93.9	0	6
17	34	93.9	2	4
17	35	93.9	2	4
22	12	92.9	1	6
22	15	92.9	6	1
22	40	92.9	2	5
25	3	91.8	4	4
25	6	91.8	6	2
25	11	91.8	0	8
28	27	90.8	8	1
28	28	90.8	3	6
28	39	90.8	0	9
31	16	88.8	11	0
32	1	87.8	8	4
32	19	87.8	8	4
34 [1]	21	87.3	7	3
35	31	86.7	7	6
36	18	84.7	12	3
37 [2]	8	83.5	3	13
38	37	81.6	2	16
39	33	80.6	16	3
40	36	78.6	10	11
41	20	74.5	21	4
42 [3]	30	59.5	21	9

[1] 79 specimens. [2] 97 specimens. [3] 74 specimens.

Figure 2. Proficiency of participating laboratories in detecting and identifying all species of organisms reported to be present by referees ("B" scores).



On 1,355 occasions the participating laboratories missed organisms reported present by two or more referees. The number of missed organisms ranged from 5 to 75, with an average of 32.3 per laboratory. The combined number of additions and omissions for the participating laboratories amounted to 1,955 errors, ranging from 10 to 106. The average was 46.5 per laboratory.

Factors Relating to "A" Scores

Although the scores of certain laboratories might indicate that improvement is needed, these scores furnish no information as to possible underlying reasons for the differences in proficiency. Such factors as type of specimen examined, procedures used, training and experience of the technicians, and financial status of the participating laboratories were analyzed. Whenever statistical significance was found (P approximately equal to or less than .01), it is so stated. Statistical analysis was made difficult by the small numbers and the incomplete data in some instances.

For the sake of discussion, the laboratories have been divided into three groups according to their *E. histolytica* scores in the official rank order (table 2). The upper group consists of 12 laboratories with scores above 95 percent; the middle group, of 18 laboratories with scores between 90 and 95 percent; and the lower group, of 12 laboratories with scores below 90 percent.

Type of Specimen Examined

The 98 specimens examined by the participating laboratories fall into three general types: (*a*) unpreserved stools, 44; (*b*) stools preserved in formalin, 45; and (*c*) specimens requiring examination from permanently stained fecal smears, 9 (including 3 stained fecal smears and 6 stools preserved in PVA-fixative).

Table 4 presents the "A" scores made on the three types of specimens by the upper, middle, and lower groups of laboratories. There was

Table 3. Number of times each intestinal organism was present in 74 of the evaluation specimens according to referee reports [1]

Organism	Found by two or three referees	Found only by one referee and/or by CDC	Total
Endamoeba histolytica	18	0	18
Endamoeba coli	28	9	37
Endolimax nana	21	15	36
Iodamoeba butschlii	6	0	6
Dientamoeba fragilis	1	0	1
Chilomastix mesnili	6	5	11
Giardia lamblia	3	4	7
Trichomonas hominis	0	1	1
Trichuris trichiura	7	8	15
Ascaris lumbricoides	2	2	4
Hookworm	4	3	7
Strongyloides stercoralis	0	1	1
Schistosoma mansoni	0	1	1
Heterodera species	0	3	3
Tyroglyphus species	0	1	1
Total	96	53	149

[1] No organisms found in 24 specimens.

little or no difference between the scores on the unpreserved and the formalinized specimens for each of the three groups. However, all three groups made significantly lower scores with the stained smears.

Number of Tests Performed

Although a few of the laboratories performed routinely only one test on each specimen, the majority varied the number, apparently depending upon the difficulty and the type of the specimen. Including the specimens which were submitted as stained smears, from one to a half-dozen techniques were performed on each specimen, with an average of slightly less than two tests per specimen. On an average, the upper, middle, and lower groups performed, respectively, 185, 166, and 165 tests in the examination of the 44 unpreserved and the 45 formalinized specimens (table 5). No upper group laboratory did less than 100 tests.

Type of Procedures Used

The four major types of procedures used by the laboratories in the examination of the 98 specimens were in order of frequency: temporary wet mounts, concentration techniques, permanent stains, and cultivation (table 6). All four types of procedures could be used on the unpreserved specimens but not on the other types of specimens distributed. The stained fecal smears and the specimens preserved in PVA-fixative could be examined effectively only from permanently stained preparations. The formalinized specimens could not be cultured. Permanently stained smears could not be prepared as successfully from formalinized as from unpreserved specimens. Nevertheless, the frequency of use of the four major procedures on the unpreserved specimens (temporary mounts, 41.8 percent; concentration techniques, 44.7 percent; permanent stains, 11.1 percent; cultivation, 2.4 percent) does not differ significantly from the frequencies for all specimens (table 6).

Temporary wet mounts employing saline, iodine, and other solutions were used by 41 of the 42 laboratories, and one or more concentration procedures were used by 38 laboratories. Of the various concentration procedures, the zinc sulfate technique was utilized approximately three times as frequently as any of the others (table 6). The brine-flotation technique was used rarely. Sedimentation and the acid-ether techniques (or modifications) ac-

Table 4. Average *E. histolytica* (or "A") scores made in examination of different types of specimens by upper, middle, and lower groups of laboratories in official rank order

Official rank order	Average *E. histolytica* scores (percent)			
	44 unpreserved specimens	45 formalinized specimens	9 stained fecal smears	98 specimens of all types
Upper group—12 laboratories	98. 1	97. 4	92. 6	97. 3
Middle group—18 laboratories	93. 3	94. 4	85. 2	93. 1
Lower group [1]—12 laboratories	85. 8	81. 8	66. 7	82. 2
All 42 laboratories	92. 6	89. 6	82. 4	91. 3

[1] Lower group did not report examination of 22 unpreserved specimens, 13 formalinized specimens, and 9 specimens requiring examination from stained smears, 44 in all.

Table 5. Number of tests performed on 44 unpreserved and 45 formalinized specimens by laboratories in the upper, middle, and lower groups

Official rank order	Percentage of laboratories in each group performing			Average number tests per laboratory
	100 tests or less	101 to 200 tests	201 tests or more	
Upper group—12 laboratories	0	58	42	185
Middle group—18 laboratories	17	66	17	166
Lower group—12 laboratories	25	50	25	[1] 165
All 42 laboratories	14	60	26	172

[1] Lower group did not report examination of 22 unpreserved and 13 formalinized specimens.

counted for slightly more than one-third of the concentrations performed. Several of the laboratories indicated that they employed the formalin-ether sedimentation technique.

Twenty-one of the laboratories prepared permanently stained smears in the examination of the unpreserved and formalinized specimens. Probably owing to the difficulty of staining formalinized specimens, the procedure was used approximately one-half as frequently on that type of specimen. According to the reports of the laboratories, several procedures were used in preparing the permanently stained smears. The Heidenhain iron-alum hematoxylin technique was used in over 50 percent of the occasions. In 25 percent, the technique was designated simply as a modified Heidenhain procedure. Of the remaining instances, where the modifications were specified, Tompkins and Miller's technique was used 87 times, Goldman's 71, Brown's 66, and Kessel's 21.

Only three laboratories used cultivation in the examination of the unpreserved specimens. The media used were Cleveland and Collier's with or without the addition of streptomycin, and modified Boeck and Drbohlav's egg slant or modified Loeffler's blood serum with fluid overlays.

Table 7 indicates the percentages of laboratories in the upper, middle, and lower groups which employed the four major types of procedures routinely or frequently in the examination of the specimens. Since 9 of the specimens could be examined only from permanently stained smears, they have been excluded from this tabulation. Only the 44 unpreserved specimens were considered in determining the frequency of use of permanently stained smears and cultivation since the techniques were not fully applicable to the formalinized specimens.

A large proportion of the laboratories in each of the three groups frequently used temporary wet mounts and concentration procedures. Permanently stained smears and cultivation were used more extensively by the lower group than by the two higher groups. However, although only one laboratory (8 percent) in the upper group used either of these techniques frequently, six (50 percent) used stained smears and one (8 percent) used cultivation as supplementary procedures.

The most common combination of any two procedures was that of wet mounts and concentration techniques. This combination was used by 28 of the laboratories. Only one laboratory in each of the upper two groups employed three procedures routinely, while four laboratories did so in the lower group.

Experience and Training

According to the returned questionnaires, the participating laboratories examine from 100 to 200,000 stool specimens for intestinal parasites each year. The volume of this type of

Table 6. Types of procedures and frequency of use by participating laboratories in examination of the evaluation specimens

Types of procedures	Number times used	Percent
Temporary wet mounts	3, 792	44. 0
Concentration techniques	3, 717	43. 2
Zinc-sulfate flotation	*2, 566*	*29. 9*
Sedimentation	*909*	*10. 5*
Brine flotation	*71*	*. 8*
Acid-ether (or modification)	*171*	*2. 0*
Permanent stains	980	11. 3
Cultivation	129	1. 5
Total	8, 618	100. 0

Table 7. Percentage of laboratories in upper, middle, and lower groups employing four types of procedures routinely (or frequently) in examination of evaluation specimens

Official rank order	Percentage of laboratories in each group employing techniques routinely (or frequently)			
	Temporary mounts [1]	Concentration technique [1]	Permanent stain [2]	Cultivation [2]
Upper group—12 laboratories	100	92	8	0
Middle group—18 laboratories	100	61	11	6
Lower group—12 laboratories	83	67	42	8
All 42 laboratories	95	71	19	5

[1] Performed on 89 unpreserved and formalinized specimens.
[2] Performed on 44 unpreserved specimens.

work can be taken as an indication of the parasitological experience of the technicians. Table 8 presents information on the number of specimens examined by the laboratories in the three "A" score groups. It should be noted that the upper group included the largest percentage of the laboratories examining more than 1,000 specimens each per annum.

The thoroughness of the routine parasitological examinations is also indicative of experience. Ten laboratories in the upper group, eight in the middle group, and six in the lower group, use routinely two or more techniques in the examination of the stool specimens that are received. Since a laboratory receiving only a few specimens a year may employ several procedures on each specimen, a better index of experience is perhaps obtained if the thoroughness of examination and volume of work are combined. Of the laboratories in the upper, middle, and lower groups which examine more than 1,000 specimens each year, a significantly greater number in the upper group use multiple techniques routinely (table 8).

In the questionnaire, the laboratories were requested to give information on the training of the personnel performing the parasitological examinations. The type of training reported was so varied that it was not possible to analyze all of the information given. However, it is possible to correlate the data in reference to specific training in the laboratory diagnosis of parasitic diseases. Twenty-six of the laboratories reported that a total of 41 individuals examining stool specimens in their laboratories had attended refresher courses in this specific field. Eighty-three percent of the laboratories in the upper group, 65 percent in the middle, and 42 percent in the lower group had individuals who had attended the courses (table 8). The average number of trained persons per laboratory was greatest in the upper group.

Population Served and Workload

In general, the more populous States were represented by the laboratories in the upper group of the "A" scores (table 9). The average population represented by this group was over a million and a half greater than that of either of the lower two groups. Furthermore, rather large proportions of the States represented by the laboratories in the lower two groups had populations of less than a million each.

The number of tests performed by a technician per annum can be considered as indicative of the work load. Information which was available on 37 laboratories is presented in table 9. In the individual laboratories, syphilis serology accounted for 40 to 89 percent of the tests performed, with an over-all average of 71 percent. Although there are inequalities due to the difference in volume of syphilis serology, and to the variety of other tests performed, they tend to average out within the different groups of laboratories. The average number of tests was the lowest in the upper group. In 25 percent of the laboratories in the upper group, the workload was less than 10,000 tests per technician.

Financial Status of the Laboratories

Information on financial status was available on 38 of the participating laboratories. The data indicated a significant trend in the relationship between higher total budgets and the greater proficiency of the laboratories in the upper group (table 10). The average budget

Table 8. Number of laboratories examining over 1,000 stool specimens per annum and percentage of laboratories with personnel trained in laboratory diagnosis of parasitic diseases

Official rank order	Parasitological work per annum			Laboratories with personnel trained in laboratory diagnosis of parasitic diseases	
	Laboratories examining over 1,000 specimens		Number of laboratories using multiple techniques routinely	Percent	Average number persons per laboratory
	Number	Percent			
Upper group—12 laboratories	8	67	7	83	1.5
Middle group—17 laboratories [1]	7	41	1	65	.9
Lower group—12 laboratories	3	25	0	42	.6
All 41 laboratories	18	44	8	63	1.0

[1] 1 laboratory did not return questionnaire.

for the upper group was over $280,000 greater than that for either of the other two groups. Fifty percent of the laboratories in this group had annual budgets of more than $301,000. The average per capita expenditure was almost twice as much for the upper group as for either of the other two groups (table 10). This trend of higher total budgets among laboratories in the upper score groups is significant.

Discussion

The *E. histolytica* scores of the 42 laboratories in the evaluation do not present a normal curve of distribution. Thirty of the laboratories made scores greater than 90 percent. In other words, this evaluation did not succeed in separating the really superior laboratories from the others. The inclusion of more difficult specimens and a greater number of positive *E. histolytica* specimens might have resulted in a better separation of the laboratories. However, 18 of the 98 specimens were positive for *E. histolytica*, which represents almost twice the generally agreed upon incidence of this parasite in the United States. Furthermore, 12 of the specimens distributed were more difficult, but were excluded from the evaluation for lack of agreement by the referees. With the same percentage of positives and the same degree of difficulty, a better separation of the laboratories probably would have been obtained if it had been feasible to include a much greater number of specimens in the evaluation.

Despite the absence of clear-cut separation of the laboratories, it is interesting to observe the relationship between favorable laboratory conditions and the greater proficiency of the laboratories in the upper group of this evaluation. Although statistical significance was not found in many of these relationships, the consistent trends in favor of the more proficient laboratories are worthy of note, and perhaps are suggestive of possible correlations. A discussion of these conditions may be of assistance to laboratories which undertake to improve their proficiency in view of the results of this evaluation.

The importance of performing multiple tests is suggested by the information on the number of tests used by the participating laboratories in their examinations of the evaluation specimens. On the whole, the more successful laboratories performed somewhat greater numbers of tests. Practically all of the laboratories in the upper group performed two or more tests on each specimen received. However, sheer numbers of tests did not appear to insure greater proficiency since one-fourth of the laboratories in the lower group performed more than two tests on each specimen. The selection of appropriate procedures was probably of greater importance.

The laboratories in the upper group placed greatest emphasis upon the wet mounts and concentration techniques and generally used permanently stained smears and cultivation methods only as supplementary procedures. On

Table 9. Proficiency of laboratories in relation to population of States or Territories and the work load of technicians

Official rank order	Population of States and Territories [1]				Workload in tests per annum per technician [2]			
	Percentage in each group with			Average (millions)	Percentage in each group performing			Average (thousands)
	1 million or less	1 to 5 million	Over 5 million		10 thousand or less	10.1 to 20 thousand	20.1 thousand or more	
Upper group—12 laboratories	8	59	33	4.1	25	58	17	14.5
Middle group—18 laboratories	33	61	6	2.1	0	33	67	22.2
Lower group—12 laboratories	42	50	8	2.5	10	60	30	21.4
All 42 laboratories	29	57	14	2.8	11	49	40	19.5

[1] Information from the 1950 census.
[2] Information available on 12, 15, and 10 laboratories, respectively, for the upper, middle, and lower groups, 37 in all.

the other hand, several of the laboratories in the lower groups made extensive use of a variety of techniques. Theoretically, the greater the variety of procedures performed, the greater should be the number of infections found. But in some instances it appeared as though certain laboratories attempted to compensate for a lack of knowledge of morphological characteristics by performing several techniques, including the more intricate procedures of staining and cultivation.

Although permanently stained smears were prepared routinely by only one laboratory in the upper group, six others used the technique occasionally. This practice of the more proficient laboratories would tend to emphasize the importance of this type of preparation, particularly as a supplementary procedure for difficult specimens. It probably reflects the good practice of staining the pathogenic protozoa and suspicious organisms in order to maintain a permanent file and to seek collaboration from reference diagnostic centers when desired.

On the whole, the participating laboratories

Table 10. Proficiency of 38 laboratories in relation to financial status, upper, middle, and lower groups [1]

Official rank order	Annual budget of laboratories (thousands)				Per capita expenditure for laboratory services (cents)			
	Percentage in each group with—			Average (thousands)	Percentage in each group with—			Average (cents)
	$200 or less	$201 to $300	$301 or more		5.0 or less	5.1 to 10.0	10.1 or more	
Upper group—12 laboratories	25	25	50	472	16	42	42	11.7
Middle group—16 laboratories	81	6	13	186	44	37	19	6.7
Lower group—10 laboratories	80	20	0	119	40	50	10	6.5
38 laboratories	63	16	21	259	34	42	24	8.3

[1] No information available on 4 laboratories.

made significantly lower scores on those specimens which required examination of stained smears than on the unpreserved and formalin-preserved specimens. This probably indicated unfamiliarity with stained smears. On the other specimens which could be examined by permanently stained smears if desired, only one-half of the laboratories employed the technique. From the questionnaire and other information, it is known that many of the public health laboratories of this country seldom or never use the permanently stained smear in the examination of diagnostic specimens that they receive. Although in some laboratories the technique may be too expensive to be employed routinely on all specimens, it would certainly be advisable for all laboratories to be equipped to prepare permanently stained smears when needed as a supplementary procedure and in the examination of certain types of specimens (for example, those preserved in PVA-fixative).

With current procedures, cultivation for intestinal protozoa is not very applicable to public health laboratories, since they generally receive mailed-in specimens which may be several days old. This probably accounts for the fact that only three participating laboratories used the technique during the evaluation.

Probably of greater importance than technical procedures was the knowledge of the parasites possessed by the individuals who performed the examinations. This is likely to be true more often in parasitology than in other types of laboratory work. The techniques available to the technician do not give objective "yes" or "no' results which can be easily read, such as the presence or absence of hemolysis, a precipitate, acid, or gas. Regardless of the parasitological technique used, the laboratory report of *E. histolytica* must be based on the morphological identification of the organisms recovered. The mere finding of amebas is not sufficient since there are other species that might be recovered by the same technique. Unfortunately, the ability to differentiate the intestinal amebas cannot be learned easily from textbooks. It requires intensive training under a competent parasitologist and months of supervised experience before a person can reliably differentiate the amebas. Furthermore, the diagnostic ability is not a skill that can be maintained without constant practice. The results of this evaluation tend to confirm the importance of experience and training since in general the laboratories in the upper group of the *E. histolytica* scores perform greater volumes of parasitological work each year and have more individuals who have received special training in this specialty.

As might be expected, there appears to have been a financial relationship with the results of this evaluation. In general, the laboratories in the upper group were significantly better financed than those in the lower two groups Since the laboratories in this evaluation are dependent upon public funds, it is only natural to find a larger number of the more populous States in the upper group. In addition, this group of laboratories has a per capita expenditure almost double that of each of the lower groups. Therefore, these laboratories apparently can afford to have more technicans for the volume of work performed, use a greater variety of tests routinely, and send more of their technicians to refresher laboratory training courses. Nevertheless, wealth alone is not sufficient as evidenced by the fact that several wealthy laboratories in heavily populated States made relatively poor scores. The results of this evaluation would suggest that in seeking to improve laboratory performance in intestinal parasitology, primary consideration should be given to wise selection of available techniques and the thorough training of technical workers.

Summary

1. Forty-two laboratories participated in the first evaluation of parasitology performed in State and Territorial health laboratories. The study involved the examination of 98 stool specimens distributed by the Communicable Disease Center as unpreserved specimens (44), formalinized specimens (45), stained fecal smears (6), and specimens preserved in PVA-fixative (3).

2. The scores made by the laboratories in determining the presence or absence of *E. histolytica* ranged between 59.5 and 99.0 percent, with all but 12 of the laboratories making scores above 90.0 percent. The laboratories were also scored in reference to reporting other intestinal

parasites determined to be present by referee laboratories.

3. In order to furnish more information which might serve as a basis for eliminating deficiencies, the relative proficiency of the laboratories is discussed in relationship to the type of specimens examined, the technical procedures used, the training and experience of the technicians, and the financial status of the laboratories.

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Manpower Policy

To help meet the problem of critical manpower shortages, the Office of Defense Mobilization in September outlined an information and guidance program for employers, educational institutions, professional associations, and Government agencies concerned with the training and utilization of scientists and engineers.

The Office of Defense Mobilization statement was published as ODM Defense Manpower Policy No. 8 and appeared in the Federal Register on September 6, 1952. The statement included a discussion of the problem as well as a series of recommendations which are applicable to professional and technical personnel employed by public health agencies—physicians, dentists, and nurses as well as scientists and engineers. Employers are urged to:

Review and reevaluate the duties, responsibilities, training, and experience requirements of technical positions to determine the minimum qualification levels required for each position, and to develop research leaders and administrators;

Cooperate with educational institutions, in the development of on- and off-the-job training programs for technical personnel and in the selection and training of subprofessional personnel to relieve scientists and engineers of routine duties;

Assure salaries that are commensurate with the skills and contributions of professional technicians;

Consult with public employment offices to avoid recruitment activities disruptive to high-urgency defense work, and to cooperate with employer associations in implementing industry-wide measures to alleviate the effects of technical personnel shortages and in expanding scholarship programs for promising students who otherwise might be unable to complete their education;

Provide comprehensive employment information to local Selective Service boards, and appropriate military authorities, for their use in classification of registered employees engaged in essential scientific activities and in determining eligibility for delay in recall to active duty for essential employees so subject;

Utilize fully women and members of minorities with scientific training;

Cooperate with public and private agencies in determining current and long-range requirements and resources of scientists and engineers and in developing relevant information regarding employment, such as salaries, hours, mobility, and working conditions.