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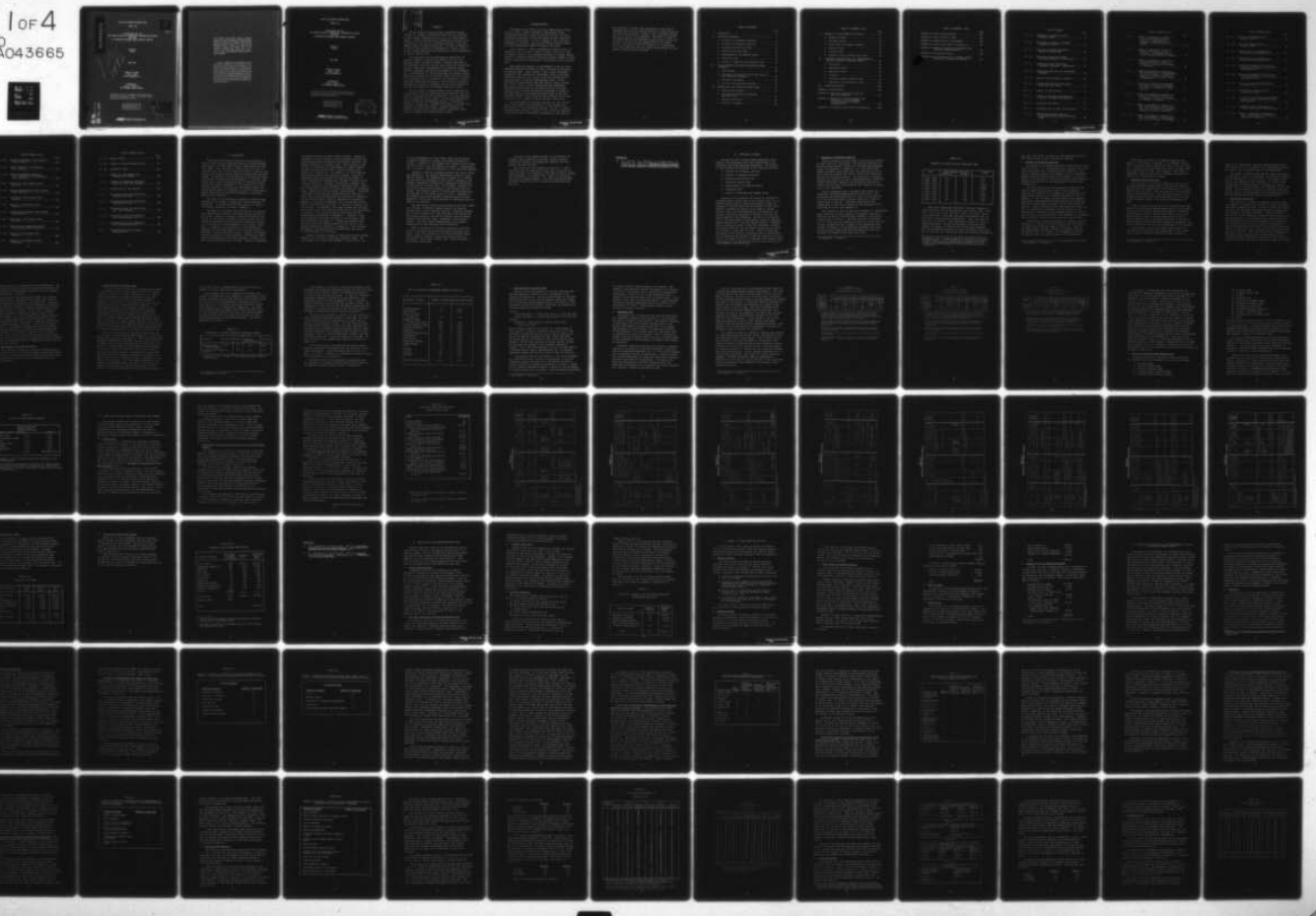

HEALTH SYSTEMS DIVISION NOTE

HSDN 77-5

EVALUATION OF THE AIR FORCE CLINICAL LABORATORY AUTOMATION SYSTEM (AFCLAS) AT WRIGHT-PATTERSON USAF MEDICAL CENTER

Volume II
Analysis

May 1977

Richard C. Brooks
Irving J. Casey
Paul W. Blackmon, Jr.

Approved by
Harry E. Emlet, Jr.
Vice President—Health Systems

Conducted for, and in cooperation with, the Directorate of Medical Plans and Resources, Office of the Surgeon General, Headquarters United States Air Force.

analytic services inc.

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ABSTRACT

The Air Force Clinical Laboratory Automation System (AFCLAS) is a medical information system that was installed in the clinical laboratories of two U.S. Air Force medical centers. This two-volume report presents the findings of an evaluation of the impacts of installing AFCLAS at the USAF Medical Center, Wright-Patterson AFB. The goal of AFCLAS is to improve the operation and management of clinical laboratories, thereby enhancing the contribution of the laboratories to quality patient care.

The evaluation plan was developed by identifying 58 potential impacts of introducing AFCLAS in place of the existing manual information system. Subjects addressed by the hypotheses included clerical tasks inside and outside the clinical laboratory; completeness of the medical records; time for processing laboratory test requests; and acceptance by, or satisfaction of, various personnel and patient groups. Data were collected at two different times—the first, period X, was before AFCLAS was installed, and the second, period Y, was after AFCLAS was operational. The evaluation included a cost-benefit analysis to determine the net cost of AFCLAS as well as an analysis of the nondollar benefits of AFCLAS.

The cost-benefit analysis showed that the expected cost of operating a clinical laboratory using AFCLAS was $382,123 more per year than the cost of operating a clinical laboratory using the previous manual system. The one-time installation cost of AFCLAS was an additional $91,631. The nondollar benefits of AFCLAS are: probable improvement in patient care, provision of cumulative reports, improved legibility of reports, easy retrieval of test results, additional information on reports, and improved report format.

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Lt.Col. Melvin B. Dobbs, Directorate of Medical Plans and Resources, and Dr.(Lt.Col.) Rudolf G. Bickel and Lt.Col. Nedd D. Mockler, Office of the Assistant Secretary of Defense (Health Affairs), Tri-Service Medical Information System (TRIMIS) Program Office, significantly contributed to the design of the evaluation plan.

The authors are grateful to the members of the Air Force Management Engineering Teams for their invaluable contribution to the evaluation. Capt. Aubrey F. Hunt, Chief, Management Engineering Team, Andrews Air Force Base, served as the data collection team chief for the Air Force and coordinated the data collection at both the USAF Medical Center, Wright-Patterson AFB, and Malcolm Grow USAF Medical Center, Andrews AFB. Capt. Gerald R. Riley, Wright-Patterson Management Engineering Team, served as the project officer at Wright-Patterson AFB, provided consultative assistance to ANSER in the study design, and managed and participated in the data collection effort. Capt. Riley was ably assisted in the data collection by Lt. Thomas R. Porter and SSgt. Gary Clark.

The staff members of Analytic Services Inc. who contributed to the research and publication of this document are too numerous to list completely; however, the work of several deserves special thanks. Richard F. Corn, while not appearing as an author, made a noteworthy contribution to the research.

Miss Francine P. Shorter also contributed to the results presented herein by her diligent efforts in computer programming and data reduction. Eileen P. Neely assisted considerably in the review of the document. The work of members of the ANSER Publications Department significantly improved the clarity of the text and the presentation of the tables. Finally, the authors thank Kitty Salazar for coordinating all of the typing and also for typing large portions of this document during several revisions.

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I. INTRODUCTION

This report presents the findings of the evaluation of the Air Force Clinical Laboratory Automation System (AFCLAS) being used at the USAF Medical Center, Wright-Patterson AFB, Ohio (MCWP). The evaluation at MCWP is the first part of a two-part study that is also evaluating AFCLAS at another site, the Malcolm Grow USAF Medical Center at Andrews AFB, Maryland (MGMC). The purpose of the evaluation is to assess the impact of AFCLAS on the operation and management of a clinical laboratory and on users and beneficiaries of laboratory results outside the clinical laboratory. The results of the evaluation are intended to aid those who must decide whether the AFCLAS system should be introduced at other Air Force medical centers and whether it should be continued or terminated where already installed.

The report of the evaluation performed at MCWP has been prepared in two volumes, of which this volume (Analysis) is the second. It provides the detailed analysis to support the findings presented in Volume I (Summary).

The sections of Volume II are organized by the areas of major analyses with Chapter I providing a brief overview of the volume. Chapter II contains a detailed statistical discussion of the effect of AFCLAS on activities that are particularly significant either to users of laboratory results or for the operation and management of the clinical laboratory. In Chapter III the results of 31 time studies are presented with analyses showing how the activity times are converted to dollar benefits or costs. Chapter IV discusses new tasks required by the introduction of AFCLAS that necessitate the assignment of full-time personnel, whether or not these persons are being fully utilized. Chapter V summarizes

the dollar benefits and dollar costs of AFCLAS. Chapter VI presents an in-depth summary of the information obtained from questionnaires and interviews with physicians, patients, and several categories of hospital staff. Also included in this section is a discussion of improvements to AFCLAS suggested by users during the interviews. Nondollar benefits are summarized in Chapter VII. In Appendix A the most important terms used throughout the report are defined. Appendix B presents the data and analysis for deriving the number of tests requested from workload data routinely collected in the clinical laboratory. Appendix C reproduces in summary form the data collected by the Management Engineering Team. Appendix D summarizes the data for scoring the physician, registered nurse, laboratory staff and patient questionnaires. The period Y versions of the physician, registered nurse, laboratory staff, and patient questionnaires are reproduced in Appendix E, and the data collection forms are reproduced in Appendix F. Appendix G lists the 58 hypotheses used to guide the development of the evaluation plan [Ref. 1], the data collection, and the analysis. In Appendix H, the power consumed and the operating cost for both the computer system and the air-conditioning are derived. The nondollar benefits associated with the questionnaires are derived in Appendix I. Appendix J gives the statistical tests that were used in the analyses of the areas presented in Chapter II. A summary of opinions about the most significant lessons learned in the course of the AFCLAS evaluation is presented in Appendix K. This includes discussion of modifications to the system that may improve its effectiveness and efficiency.

Volume I provides a summary of the evaluation and analysis methods and of the most significant findings at MCWP. The two volumes of the report were planned to allow Volume I to

be read independently of this volume, which may be omitted or used as reference to support the findings presented in Volume I. However, it was assumed that a reader of this volume would be familiar with the material in Volume I. Additionally, Ref. 1 provides a detailed description of the evaluation methods.

AFCLAS is a medical information system that the Air Force has installed in the clinical laboratories of two Air Force medical centers. The immediate goal of AFCLAS is to improve the operation and management of the clinical laboratory, and thereby, ultimately to enhance the laboratory's contribution to the quality of patient care. The hardware, software, and functional operation were defined in the contract with the vendor. The technical aspects of AFCLAS were evaluated prior to acceptance of the system by the Air Force. Therefore, it was assumed that during the data collection period and the preceding 3 months that AFCLAS operated in compliance with the terms of the contract.

The USAF Medical Center, Wright-Patterson AFB, Ohio (MCWP) is a 320-bed, 21-bassinet, general medical and surgical hospital with a large outpatient service. Inpatient bed-days for FY 1975 totaled 93,137, and there were 8,861 admissions. The average occupancy rate was 78.5 percent and the average length of stay was 10.5 days. Outpatient visits totaled 419,841. The staff totaled approximately 1,100 members. Expenditures in that same year were $13,500,000.

MCWP is accredited by the Joint Commission on Accreditation of Hospitals and has several approved residency programs. Also, MCWP operates as a military consultant center, direct referral hospital, and an area medical center for Continental United States (CONUS) Area 3, which includes 12 base medical facilities.

Included in the present services of the hospital are intensive care, psychiatric services, physical therapy, occupational therapy, and appropriate inpatient and outpatient ancillary services.

The evaluation effort started in June 1974. A draft evaluation plan was completed in July 1974; it was then revised, extended, and pretested at USAF Medical Center, Keesler AFB, Mississippi, in December 1974. Based on the pretest, the plan was further modified. Data were collected at MCWP from March through May 1975, and again from March through May 1976.

REFERENCES

(1) R. C. Brooks, R. G. Carlisle, I. J. Casey, and P. W. Blackmon, Jr. HSDN 77-3—Evaluation Plan for the Air Force Clinical Laboratory Automation System (AFCLAS). Falls Church, Virginia: Analytic Services Inc., 1975.

II. STATISTICAL STUDIES

Statistical tests of significance associated with a number of the hypotheses which were investigated in the evaluation were conducted where appropriate. The results of these analyses are discussed in the following sections:

A. Frequency of Telephone Inquiries

B. Duration of Telephone Inquiries

C. Reception Desk Service Time

D. Laboratory Service Time

E. Completeness of the Medical Record

F. Turnaround Time*

G. Errors in Outpatient Test Request Slips.

Sections A and B describe the results of the study of telephone inquiry phone calls to the clinical laboratory at Wright-Patterson Medical Center with respect to both the frequency of inquiry calls and the duration of those calls. Section C presents the results of the study of patient service time at the reception desk in the laboratory, and Section D contains an analysis of the total time that the patient spends in the laboratory. Section E is an examination of the completeness of the medical record in Outpatient Medical Records and in Inpatient Medical Records. Completeness is analyzed in terms of both the percentage of laboratory reports that get into the medical record and the amount of time that it takes them to do so. Section F describes the results of the study on turnaround time of reports within the laboratory and Section G gives the results of the analysis of the number of errors in outpatient test request slips.

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* See Appendix A for definition.

A. Frequency of Telephone Inquiries

Inquiry telephone calls are those calls that are requests for test results or test status. The clinical laboratory at Wright-Patterson Medical Center has a decentralized telephone system for responding to inquiries, i.e., the receptionist answers telephone calls coming into the laboratory on one of five lines and transfers the inquiry calls to the laboratory section that performed the test. The frequency of telephone inquiries was studied in order to determine whether AFCLAS has induced significant changes in the telephoning patterns of health care providers in the hospital with respect to inquiry calls to the laboratory.

Data on telephone inquiry frequency were tested for a significant decrease between period X and period Y. Data collection was accomplished from 0730 hours to 1630 hours on 15 of the 20 working days of period X and on 19 of the 20 working days of period Y. Data were collected by the receptionist in the form of tallies in the appropriate hour time block on Form 5 (see Appendix F).

The analysis of data in this area consisted of a statistical test* comparing the mean frequency of telephone inquiries in each hour in period X with the mean frequency in the corresponding hour in period Y. The data collected in periods X and Y for this area are presented in Table II-1 along with the P value (probability that a change in the frequencies from period X to period Y of the magnitude indicated could occur by chance alone) associated with the statistical test conducted on the change in each hour time block.

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* See Appendix J, Section A.

TABLE II-1

FREQUENCY OF INQUIRY CALLS AT RECEPTION DESK

HOUR	MEAN FREQUENCY PER HOUR		P VALUE *
	Period X	Period Y	
0730 - 0830	9.6	9.2	0.37
0830 - 0930	6.7	8.3	0.96
0930 - 1030	7.5	7.0	0.30
1030 - 1130	6.1	3.5	0.0002
1130 - 1230	4.3	2.3	0.001
1230 - 1330	4.6	4.0	0.22
1330 - 1430	5.9	3.8	0.004
1430 - 1530	3.7	2.1	0.002
1530 - 1630	0.5	0.8	0.90

There was a significant decrease in the mean frequency of inquiry calls in four of the nine hour time blocks, 1030 - 1130, 1130 - 1230, 1330 - 1430, and 1430 - 1530. The first 3 hours of the day (0730 - 1030) were the high-volume periods with 327, 267, and 253 inquiry calls, respectively. There were very few calls (24) in the 1530 - 1630 time block on which to conduct a significance test. The data are somewhat inconclusive with respect to frequency of inquiry calls; while mean frequency per hour decreased in seven out of nine time blocks, only since four of the nine hour time blocks showed a significant decrease in

*Probability that a change of the given magnitude could occur by chance alone. A null hypothesis of no change was statistically tested against an alternative hypothesis of a decrease in the mean frequency of inquiry calls from period X to period Y.

this area from period X to period Y; the remaining five hour time blocks failed to show a significant decrease.

B. Duration of Telephone Inquiries

The duration of telephone inquiries is defined as the total time of the call, i.e., receptionist time, time on "hold," and time spent talking with laboratory section personnel. Duration of telephone inquiries was studied in order to determine whether AFCLAS has induced significant changes in the accessibility of information to laboratory personnel when answering telephone inquiries or in the availability of test results to physicians.

Data were collected by the Management Engineering Team (MET) by observing the light on each of four telephone lines on the receptionist's telephone and recording the duration of each inquiry call (timed by stopwatch) on Form 1, Appendix F. Data collection occurred during eight randomly selected but predetermined 15-minute observation periods per day for 20 working days of period X and 20 working days of period Y. Fewer observations than anticipated were taken due to: the difficulty of observing the four buttons on the receptionist's telephone for any extended period of time and the fact that a high percentage of the telephone calls observed during the data collection periods were not inquiry calls.

The analysis of data for duration of telephone inquiries consisted of a statistical test* comparing the mean duration in period X with the mean duration in period Y. Based on 146 observations, the mean duration of telephone inquiries for period X was 2.05 minutes. The corresponding average for period Y was 2.10 minutes based on 201 observations.

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* See Appendix J, Section B.

The change in duration of telephone inquiries from period X (2.05 minutes) to period Y (2.10 minutes) was not found to be statistically significant even at the 0.20 level; i.e., a change of this magnitude could occur by chance alone more than 20 times in 100. There appears to have been no significant change in duration of telephone inquiries as a result of the introduction of AFCLAS.

C. Reception Desk Service Time

The time that it takes for a patient to obtain service at the laboratory reception desk is the time from when he presents his test request form to the receptionist until the time he leaves the desk. This time does not include queueing time at the reception desk. The time spent waiting at the reception desk can affect patient satisfaction and can also result in queues forming if the service time becomes too long.

Data on patient service time at the reception desk were tested for a significant change between period X and period Y. Data collection occurred during three randomly selected but predetermined 30-minute observation periods per day for 20 working days of period X and 20 working days of period Y. Data collection Form 10, Appendix F, was used to record the patient service times, which were obtained by stopwatch. All data collection in this area was accomplished by MET personnel.

The analysis of data for reception desk service time consisted of a statistical test* comparing the mean service time in period X with the mean service time in period Y.

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* See Appendix J, Section B.

Based on 475 observations, the mean reception desk service time for period X was 25 seconds. The corresponding average for period Y was 29 seconds based on 798 observations.

The change in reception desk service times from period X (25 seconds) to period Y (29 seconds) was found to be statistically significant at the 0.05 level. The reception desk service time appears to have increased as a result of the introduction of AFCLAS although an increase of 4 seconds probably has very little impact on the operation of the laboratory. This increase may be due to a somewhat longer processing time by the receptionist for test request forms used with the AFCLAS system than those used during period X.

D. Laboratory Service Time

The time that it takes for a patient to obtain laboratory service is measured from the time he enters the laboratory with a request slip until the time he leaves the laboratory after all necessary specimens have been collected from the patient by laboratory personnel. This time includes service time at the laboratory reception desk (Section C) and any queueing time at the reception desk, both of which are small relative to the overall time spent in the laboratory. The laboratory service time can impact significantly on patient satisfaction and can also affect patient costs since time in the laboratory can, in some cases, be translated into time away from work. Due to the difficulty of establishing the dollar costs associated with patient service time in different personnel categories, the impact of any change in laboratory service time was not measured in terms of dollars.

Data on the time that patients spend in the laboratory were tested for a significant change between period X and period Y. Data collection occurred during three randomly selected but predetermined 30-minute observation periods per day for 20 working days of period X and for 19 working days of period Y. A card (See Form 11, Appendix F) was stamped with time and date and given to the patient when he arrived at the laboratory; this card was collected and stamped with time and date again when the patient left the laboratory. Management Engineering Team (MET) personnel handed out and collected the majority of the data collection cards and ensured that the receptionist collected cards in their absence. Some patients, however, neglected to turn in their cards when they left the laboratory. Nevertheless, the response rates for period X and period Y were 92.8 percent and 90.8 percent, respectively.

The principal part of the analysis in this area consisted of a statistical test* comparing the mean laboratory service time in period X with the mean laboratory service time in period Y. It was decided to separate the service time data of those patients who were at the laboratory for glucose-tolerance testing from the remainder of the data since the series of glucose tests is very time consuming. Since there was a limited amount of data on service times for glucose-test patients, a statistical test was not conducted; however, the mean service times for glucose-test patients were computed for period X and period Y.

The laboratory service time for each patient was obtained by simply subtracting the time he entered the laboratory from the time he departed. Based on 394 observations (not including glucose-test data), the mean laboratory service time for period X was 18.9 minutes. The corresponding average

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* See Appendix J, Section B.

for period Y was 31.7 minutes based on 439 observations. The mean laboratory service times for glucose-test patients were 85.7 minutes (25 observations) in period X and 45.3 minutes (37 observations) in period Y.

The change in laboratory service times (not including glucose-test data) from period X to period Y was found to be statistically significant at the 0.002 level. The laboratory service time appears to have increased as a result of the introduction of AFCLAS. Possible explanations for this increase in period Y include: 1) more time is needed to perform the patient registration function (name, Social Security number, etc.) and to correct test request information, 2) patient labels must be printed before blood and urine specimens can be drawn, and 3) labels and results are paired after specimens are drawn. In light of the above increase, it is somewhat surprising that the mean service time in the laboratory for glucose-test patients decreased from period X (87.7 minutes) to period Y (45.3 minutes). However, these averages were based on relatively few observations; additional data would be necessary in order to establish more reliable estimates for laboratory service times for glucose-test patients.

E. Completeness of the Medical Record

This section discusses the accuracy and completeness of the patient's medical record with respect to both the elapsed time until the laboratory reports to get into the record and the percentage of reports that are misplaced and do not reach the record.

1. Outpatient Medical Records (OMR)

A patient's medical record is not complete with respect to the laboratory work that has been done for him unless it contains a report of all tests completed for him. Medical record completeness was therefore defined for the OMR evaluation as the percentage of completed outpatient laboratory reports that are ultimately found filed in the medical record after completion by the laboratory. The time between completion of outpatient reports by the laboratory and their arrival in OMR was also examined. Completeness of the medical record was included in the evaluation since a benefit of AFCLAS was expected to be not only a reduction in the number of laboratory reports that did not get into the medical record, but also a reduction in the amount of time that it takes the reports to get into the record. This should improve the quality and the timeliness of patient information that is available to the physicians.

Data on the percentage of outpatient reports that did not get into the medical record were tested for a significant change between period X and period Y. Data collection by the Management Engineering Team (MET) occurred during the first 16 working days of the 20 working days of both period X and period Y. A random sample of Xerox copies of approximately 25 outpatient reports was drawn on each of the 16 days in both data collection periods. Approximately 6 weeks after the completion of the evaluation periods, the MET searched OMR for the original laboratory reports corresponding to the sample of Xerox copies. The final sample obtained for the analysis was somewhat smaller than 400 (16 days per period times 25 reports per day) due to the exclusion of those reports for which the appropriate medical record was signed

out of OMR so that a determination could not be made as to whether or not the report was in the record.

The principal part of the analysis in this area consisted of a statistical test* comparing the percentage of outpatient laboratory reports that were not in the medical record in period X with the corresponding percentage in period Y. Since several of the medical records were misplaced (rather than signed out), we conducted two comparisons: one under the assumption that the reports that should have been filed in the misplaced records had not been, and a second comparison that excluded from the analysis the reports for which the appropriate medical record was misplaced. The data are summarized in Table II-2.

TABLE II-2

PERCENTAGE OF MISSING OUTPATIENT LABORATORY REPORTS

Assumption	Period X	Period Y	Period X Minus Period Y	P Value†
Misplaced Record = Missing Report	25.4	16.5	8.9	.003
Excluding Misplaced Records	16.3	9.9	6.4	.03

† Probability that a change of the given magnitude is due to chance alone.

* See Appendix J, Section C.

There appears to have been a significant decrease in the percentage of outpatient laboratory reports that were not filed in the patient's medical record. One possible explanation for this is the distribution system. In period X, completed outpatient laboratory reports were first returned to the originating clinic and then forwarded to OMR. In period Y completed laboratory reports were sent directly to OMR. The elimination of the clinic in the distribution system may have resulted in a greater percentage of the laboratory reports in period Y having been filed in OMR than in period X.

Data were also collected in period X on the time that it takes outpatient laboratory reports to reach OMR. All laboratory reports arriving at OMR during 15 working days of period X were Xeroxed by the MET. The date that the report was Xeroxed was recorded, and this was later compared with the date on the laboratory report indicating when the report had been completed in the laboratory and was ready for distribution. Thus, it could be determined (assuming the date was legible) how long it took each report to reach OMR. The data for period X are summarized by category of report in Table II-3.

Due to the change in the distribution system between period X and period Y discussed above, the time that it took laboratory reports to reach OMR during period Y was very short (1-2 hours). Therefore, no comparison was made in this area between period X and period Y.

Laboratory reports for preoperative outpatients were not included in the analysis because handling procedures in the laboratory changed between period X and period Y.

TABLE II-3

TIME FOR OUTPATIENT LABORATORY REPORTS TO REACH OMR

Category of Report	Number of Reports	Average Time (Days)
Cardiopulmonary	53	3.28
Dermatology	6	10.33
Eye, Ear, Nose, and Throat	22	8.77
Emergency Room/ Primary Care Clinic	840	1.98
Family Practice Clinic	927	2.63
Internal Medicine	371	2.84
Neurology	5	9.80
Obstetrics/Gynecology	187	3.64
Orthopedics	25	3.36
Pediatrics	285	3.07
Radiation Therapy	70	3.83
Radioisotope	1	4.00
Stat	21	2.76
Surgery	4	1.75
Urology	102	2.53
Unknown	225	4.27
Total/Overall Average	3,144	2.81

2. Inpatient Medical Records (IMR)

Medical record completeness for the IMR evaluation was defined similarly to medical record completeness in the previous OMR discussion. Data on the percentage of inpatient reports that did not get into the medical record were tested for a significant change between period X and period Y. Data collection by the MET occurred at IMR after the completion of the data collection periods as follows:

Period X

First IMR search - 6 weeks after period X (19-20 May 1975)

Second IMR search - 3 months after period X (15 July 1975)

Period Y

IMR search - approximately 6 weeks after period Y (end of May 1976).

The IMR search in period X was based on a random sample of Xerox copies of inpatient laboratory reports similar to the procedure (16 sampling days per period times 25 reports per day or 400 reports) described for OMR. During the first 16 working days of the 20 working days of both period X and period Y, the MET also searched the patient medical records on the wards for presence of the inpatient laboratory reports. Due to the time-consuming nature of the ward search, a somewhat smaller sample (approximately 250) of inpatient laboratory reports was drawn for period Y than for period X.

The principal part of the analysis in this area consisted of a statistical test* comparing the percentage of inpatient laboratory reports that were not in the medical records in period X with the corresponding percentage in period Y. Based on 379 inpatient laboratory reports in period X, the percentage of missing reports was 4.2 percent. The corresponding percentage

* See Appendix J, Section C.

for period Y was 5.0 percent based on 238 reports. The change in the percentage missing from period X (4.2 percent) to period Y (5.0 percent) was not found to be statistically significant (P value of 0.077 or the probability that a change of this magnitude could occur by chance alone). There appears to have been no significant change in the percentage of missing inpatient laboratory reports as a result of the introduction of AFCLAS. The percentage missing in both period X and period Y was low.

F. Turnaround Time

Turnaround time is defined as the time from the arrival of a laboratory request in the laboratory to the time that the report is ready for distribution. The specific definition of turnaround time varied slightly between period X and period Y and between a routine request and a *stat* request (see Appendix A for definitions). An important objective of the laboratory is to provide results of laboratory tests to physicians as quickly as possible. Thus, a significant change in request turnaround time could have a decided impact on the timeliness of the information provided to the requesting physician.

Different laboratory sections have different turnaround times due to the nature of the tasks performed. Turnaround time was investigated separately for *stat* and routine requests, and by laboratory section, as appropriate. Routine requests were further subdivided into those associated with inpatients and those associated with outpatients. In addition, the Physician Questionnaire provided information about the physicians' satisfaction with turnaround time during periods X and Y whether a change was perceived by them.

Data on turnaround time in the laboratory were tested for a significant change between period X and period Y. Data were collected during the first 16 working days of the 20 working days of period X, and during all 20 working days of period Y. All data collected during period X that were legible and complete were used in the analysis. A sampling scheme was devised for period Y and the analysis was conducted on a sample of the total amount of period Y data. Data were collected during period X by time and date stamping the requests when they initially arrived at the laboratory, and again time and date stamping the requests when they were returned to the front desk for later distribution. During period Y, the arrival times and completion times for test requests were taken directly from the computer printout generated by AFCLAS. (See Appendix A for further details in assignment of arrival and completion times for period X and period Y.)

The turnaround times for laboratory requests were obtained by simply subtracting the arrival time at the laboratory from the completion time for each request. The principal part of the analysis in this area consisted of a statistical test* comparing the mean turnaround time in each laboratory section in period X with the mean turnaround time in the corresponding section in period Y. Routine and *stat* laboratory requests were analyzed separately, as were requests associated with inpatients and outpatients with respect to routine laboratory requests. The mean turnaround times are presented in Tables II-4, II-5, and II-6, along with the P value associated with the statistical test conducted on the change in each laboratory section.

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* See Appendix J, Section B.

TABLE II-4

TURNAROUND TIMES FOR ROUTINE

LABORATORY REQUESTS* - INPATIENTS

Laboratory Section	Unadjusted Mean Time (Hours)			Adjusted Mean Time (Hours)†		
	Period X	Period Y	P Value‡	Period X	Period Y	P Value‡
Hematology	3.30	22.69	0.000	3.30	22.69	0.000
Urinalysis	3.03	22.54	0.000	3.03	22.54	0.000
Chemistry§	-	67.06	-	-	46.03	-
Microbiology	61.82	97.63	0.000	56.42	81.78	0.000
Parasitology‖	10.90	-	-	10.90	-	-
Serology	22.96	15.88	0.023	22.96	15.88	0.023

* A probable explanation for the increase in turnaround time for routine requests is that reports in period X were distributed at 1200 hours and 1700 hours on the same day that processing was completed, while in period Y, reports of laboratory test results were printed about 0400 hours on the morning following the completion of processing.

† Any turnaround times greater than 10 days (14 days in Microbiology) were set to 10 days (14 days). Requests with turnaround times in excess of 10 days (14 days) were probably either lost or excessively delayed in verification.

‡ Probability that a change of the given magnitude could occur by chance alone. A P value of 0.000 indicates that the calculation is accurate to 3 decimal places.

§ Period X data in Chemistry were unreliable due to concurrent installation of the HYCEL-17.

‖ The small number of requests in Parasitology in period Y were processed by Microbiology. The effect on the data for Microbiology should be minimal.

TABLE II-5

TURNAROUND TIMES FOR ROUTINE

LABORATORY REQUESTS* - OUTPATIENTS

Laboratory Section	Unadjusted Mean Time (Hours)			Adjusted Mean Time (Hours)+		
	Period X	Period Y	P Value‡	Period X	Period Y	P Value‡
Hematology	2.61	11.89	0.000	2.61	11.89	0.000
Urinalysis	9.30	18.30	0.000	9.19	18.30	0.000
Chemistry§	-	159.09	-	-	35.77	-
Microbiology	36.51	62.85	0.000	35.05	53.09	0.000
Parasitology ‖	44.49	-	-	44.49	-	-
Serology	48.20	51.15	0.349	48.20	51.15	0.349

* A probable explanation for the increase in turnaround times for routine requests is that reports in period X were distributed at 1200 hours and 1700 hours on the same day that processing was completed, while in period Y, reports of laboratory test results were printed about 0400 hours on the morning following the completion of processing.

\+ Any turnaround times greater than 10 days (14 days in Microbiology) were set to 10 days (14 days). Requests with turnaround times in excess of 10 days (14 days) were probably either lost or excessively delayed in verification.

‡ Probability that a change of the given magnitude could occur by chance alone. A P value of 0.000 indicates that the calculation is accurate to 3 decimal places.

§ Period X data in Chemistry were unreliable due to concurrent installation of the HYCEL-17.

‖ The small number of requests in Parasitology in period Y were processed by Microbiology. The effect on the data for Microbiology should be minimal.

TABLE II-6

TURNAROUND TIMES FOR *STAT*

LABORATORY REQUESTS*

Laboratory Section	Unadjusted Mean Time (Hours)			Adjusted Mean Time (Hours)+		
	Period X	Period Y	Significance Level‡	Period X	Period Y	Significance Level‡
Hematology	1.74	5.51	0.001	1.73	5.25	0.001
Urinalysis	0.84§	6.14§	0.001	0.84	5.29	0.001
Chemistry	9.79	14.59§	0.001	6.29	7.99	0.05

* The turnaround times for *stat* reports presented in this table are the elapsed time for the paper reports. The physicians usually receive *stat* test results by telephone in a significantly shorter period of time.

\+ Any turnaround times greater than 24 hours were set to 24 hours. Requests with turnaround times in excess of 24 hours probably either were not true *stat* requests or were not processed promptly due to the results of the test already having been reported by telephone.

‡ Probability that a change of the given magnitude could occur by chance alone is less than the stated significance level.

§ Turnaround times for one or two test requests (per item) with unusually long turnaround times were arbitrarily set to 24 hours in order to make the mean turnaround time more realistic.

The change in turnaround times (both unadjusted and adjusted) for laboratory requests was found to be statistically significant in all sections for both routine requests and *stat* requests, with the exception of Serology requests for outpatients (P value of 0.349). There was an increase in turnaround times (both unadjusted and adjusted) in all sections for both routine requests and *stat* requests, with the exception of Serology requests for inpatients where the mean turnaround time decreased from 22.96 hours to 15.88 hours (P value of 0.023). A probable explanation for the increase in turnaround times for routine requests is the fact that reports in period X were distributed at 1200 hours and 1700 hours on the same day that processing was completed; in period Y, reports of laboratory test results were printed for distribution in the early morning of the day following the completion of processing. Although turnaround times for *stat* requests also increased significantly, it should be emphasized that these are turnaround times for paperwork, not necessarily for reporting results since the results of most *stat* tests are telephoned to the requesting physician. The increase in turnaround times for paperwork probably reflects an increase in turnaround times for reporting results, but the discrepancies may not be of the magnitude indicated in Table II-6.

G. Errors in Outpatient Test Request Slips

Outpatient laboratory test request slips arriving at the reception desk were screened for the following errors:

-1 No patient name
-2 Illegible patient name
-3 No Social Security number
-4 Illegible Social Security number
-5 Incomplete Social Security number

-6 No clinic name
-7 Illegible clinic name
-8 No date
-9 Illegible date
-10 No patient telephone number
-11 Illegible telephone number
-12 No requesting physician
-13 Illegible requesting physician
-14 No rank or relation code
-15 Illegible rank or relation code
-16 Other.

For the purposes of the evaluation, a slip is defined to be in error if one or more major errors exist (numbers 1 through 7 in the above list). A slip is defined to be correct if all requested information is on the slip and legible, or if it contains one or more minor errors (all possible errors other than numbers 1 through 7 in the above list).

In order for laboratory reports to be distributed and filed, the laboratory request slip must contain information identifying the patient and hospital area generating the test request. If this information is missing, illegible, or incomplete, laboratory staff personnel time must be expended in order to obtain the correct information.

Data on the error rate in arriving outpatient test request slips were tested for a significant change between period X and period Y. Data collection occurred during two randomly selected but predetermined 30-minute observation periods per day for 20 working days of period X and 20 working days of period Y. Management Engineering Team (MET) personnel recorded the errors on Form 9, Appendix F, along with the initials of the patients involved. Due to the fact

that the errors on two or more request slips from the same patient were highly correlated, the analysis was conducted on the basis of one request slip per patient. There were somewhat fewer observations than anticipated due to a reduced number of arrivals during the data collection periods, but this should not substantially alter the conclusions.

The principal part of the analysis in this area consisted of a statistical test* comparing the percentage of slips in error in period X with the percentage of slips in error in period Y. Based on 253 observations, the percentage of slips in period X that were in error (numbers 1 through 7 in the above list) was 12.6 percent. The corresponding error rate for period Y was 10.4 percent based on 346 observations. A total of 469 slips for the 253 arrivals, or 1.9 slips per patient, were recorded in period X. There were 767 slips recorded for the 346 arrivals in period Y, or 2.2 slips per patient.

The change in error rate from period X (12.6 percent) to period Y (10.4 percent) was not found to be statistically significant (P value of 0.47). There appears to have been no significant change in the error rate as a result of the introduction of AFCLAS.

A breakdown of the change in error rates for all error categories (numbers 1 through 15 in the above list where discrepancies due to missing, illegible, or incomplete information are aggregated within each category) is given in Table II-7. Although the percentage of errors dropped in all categories except "Social Security number" from period X to period Y, few of the categories showed a statistically significant change, particularly those deemed to be most important for identification purposes, such as patient name, Social Security number, and clinic.

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* See Appendix J, Section C.

Table II-7

CHANGE IN ERROR RATES BY CATEGORY

Category of Error	Percent Error Rate Period X, Minus Percent Error Rate Period Y	P Value *
Patient name	+ 2.5	0.27
Social Security number	- 1.7	0.58
Clinic	+ 1.6	0.49
Telephone number	+ 3.6	0.47
Physician	+ 2.4	0.28
Rank/Relation	+ 7.4	0.01
Date †	+21.9	Less than 0.001

* Probability that a change of the given magnitude is due to chance alone.

† Data obtained with respect to errors in the "date" portion of the test request slips are presented for illustrative purposes only. On many of the slips, no data were collected in this category.

III. DOLLAR BENEFITS AND COSTS OF ACTIVITIES TIME STUDIED

This chapter presents the findings of 31 time studies and the analyses showing the conversion of activity (task) times to dollar benefits and dollar costs. The data received from the Management Engineering Team (MET) at Wright-Patterson Air Force Base (WPAFB) is summarized in Appendix B and the workload constants are derived in Appendix C.

A. Time Studies

A time study is a standard work measurement technique used to determine the amount of time expended in performing a specific activity. Usually an observer measures the time with a stopwatch. By observing an activity several times, a mean time required to perform the activity can be calculated. If the number of observations is increased, then the statistical accuracy of the estimate will be improved. The methodology for the time studies reported in this chapter is specified in Air Force Manual (AFM) 25-5 Management Engineering Policies and Procedures [Ref. 1].

One problem with direct observation is the possible occurrence of a negative Hawthorne effect. When this happens the person being observed perceives himself as being threatened and may respond either by consciously or subconsciously decreasing the rate at which he works and/or changing the pattern or method of his work. The MET observers sought to minimize the negative Hawthorne effect in the AFCLAS evaluation by working with the laboratory personnel long enough to gain their confidence before taking the time measurements. In addition, the ANSER study team assured laboratory personnel

that the purpose of the evaluation was to study AFCLAS and not the efficiency of individual technicians. Further, the results of the AFCLAS evaluation should not affect laboratory manning standards.

Direct measurement of task-performance times, however, is not always feasible. Such is the case for tasks that are done on an infrequent basis or for those tasks that are not performed in an established pattern. Activity times for these tasks can often be obtained (with reduced accuracy) through the use of interviews. During the AFCLAS evaluation, several estimates of time standards were derived through interviews with laboratory personnel that were conducted according to the operational audit procedures specified in AFM 25-5.

B. Conversion of Activity Time to Net Time for Each Personnel Category

The analysis for one of the 31 time studies is described below to illustrate the method used to derive the total time that each personnel category expended on the activity based on the data collected by the MET. The calculations are performed using the data collected in period X and then repeated for the data collected in period Y.

The total time to perform a task by all personnel categories for a 3-month period (January, February, March 1975 for period X and January, February, March 1976 for period Y) is calculated by multiplying the measured activity time by the number of times the activity is repeated in the 3-month period. The total time for each personnel category is computed from the total time expended by all personnel categories by multiplying the total time for the activity by the percentage of time each personnel category spends in performing the activity.

This process is conducted for the activity times observed in period X and then for the activity times observed in period Y. For the period Y frequency we used the actual frequency observed for an activity in period Y. For the period X

frequency we estimated the frequency with which the activity would have been performed in period X if the manual methods of period X had been used to process the number of tests requested in period Y. Hence the net change in the total time for the activity is the difference between the time required to perform the activity in period Y and a computed time required to perform the activity using the manual methods of period X if the same number of laboratory tests requested in period Y had been requested in period X.

For each activity, the net time for each personnel category is computed by subtracting the time required in period X from the time required in period Y. A positive net time indicates that more time was required with AFCLAS than with the manual methods, and a negative time indicates a net savings in time due to the installation of AFCLAS.

We then computed the total net time for each personnel category by adding up the net time obtained for each of the 31 activities for a given personnel category.

Table III-1 summarizes the frequencies derived in Appendix B that are used to compute the total time per task. Table III-2 presents the computation of net times per personnel category for each of the 31 tasks. In Table III-2 each task is listed and appropriate subtasks are specified. The MET gives a more detailed discussion of each task in Appendix C.

Table III-3 gives the net change in hours per quarter by personnel category for the 31 tasks time studied. This table is derived from the data in Table III-2. In the column for net hours, a positive number indicates a net increase in time due to the installation of AFCLAS and a negative number indicates a net savings in time due to the installation of AFCLAS. Net times increased for eight of the 11 personnel categories observed and the decreases that did occur were small.

(Text continued on page 42.)

TABLE III-1

FREQUENCIES USED FOR CALCULATING

TOTAL ACTIVITY TIMES

Item	Frequency
Normal Workdays	62
Calendar Days	90
Tests Requested During Period Y *	192,600
Period X † Request Slips Which Would Have Been Required For Period Y Workload	72,600
Computer Request Cards Used During Period Y	55,900
Admit Cards Used During Period Y	36,800
Cytology Request Slips and Request Cards Used During Period Y	3,000
Pages of Reports Printed During Period Y	69,600
Inpatient Reports During Period Y	10,400
Admissions During Period Y	2,200
Blood Collection Tubes Used During Period Y	60,100
Patients Who Had Tests Processed By the HYCEL-17	7,100
Telephone Inquiries During Period X Adjusted For Period Y Workload	3,739
Telephone Inquiries During Period Y	2,567
MAMS-R Transactions During Period Y	5,074
Hospital Admissions During Period Y	2,232
Total Number of Outpatients Arriving at the Reception Desk During Period Y	14,000

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* Period Y as used in this table is January, February, and March 1976.

† Period X as used in this table is January, February, and March 1975.

TABLE III-2
RESULTS OF TIME STUDIES

Task Number	Task Description	Associated Hypotheses (Appendix G)	Period X				Period Y				Net Cost of AFCLAS (Work Hours Per Quarter, by Personnel Category)†
			Activity Time	Adjusted Frequency for Period X*	Percentage of Time for Each Personnel Category	Hours Worked by Personnel Category	Activity Time	Frequency for Period Y	Percentage of Time for Each Personnel Category	Hours Worked by Personnel Category	
1	Prepare Administrative Reports‡	1, 10									
	A 235 Report										
	Monthly		6.00 hr	3/quarter	100 NCOIC§	18.00	1.00 hr	3/quarter	100 NCOIC	3.00	15.00 NCOIC
	Quarterly		4.00 hr	1/quarter	100 NCOIC	4.00	0.50 hr	1/quarter	100 NCOIC	0.50	3.50 NCOIC
	B CAP Monthly Report		3.00 hr	3/quarter	100 Lab Officer	9.00	2.00 hr	3/quarter	100 Lab Officer	6.00	3.00 Lab Officer
	C Positive Beta Strep Listing		0.25 hr/day	62/quarter	100 Lab Supervisor	15.50	5 min/day	62/quarter	100 Lab Supervisor	5.17	10.30 Lab Supervisor
2	File Request Slips or Computer Request Cards	6									
	Chemistry		0.05 min/slip	22,400		18.67	2.00 hr/quarter	1/quarter		2.00	
	Hematology		0.05 min/slip	14,900		12.42	0.05 min/card	16,000 cards		13.33	
	Bacteriology		0.10 min/slip	14,500		24.17	3.67 hr/quarter	1/quarter		3.67	
	Urinalysis		0.05 min/slip	14,000		11.67	0.06 min/card	10,800 cards		10.80	
	Serology		0.05 min/slip	5,700		4.75	0.00 min/card	4,800 cards		0.00	
	Parasitology		0.05 min/slip	700		0.58	Included in Bacteriology	—		—	
	Specimens Shipped		0.05 min/slip	400		0.33	0.05 min/card	400		0.33	
	Coagulation						1.00 hr/quarter	1/quarter		1.00	
					50 Lab Supervisor 50 Lab Technician	Total 72.59			50 Lab Supervisor 50 Lab Technician	Total 31.13	20.70 Lab Supervisor 20.80 Lab Technician
3	Filing Worksheets and Log Books	6									
	A Chemistry		2.00 min/day	62 days	100 Lab Supervisor		1.00 min/day	62 days	100 Lab Supervisor		
	Stat Laboratory		1.00 min/day	62 days	100 Lab Supervisor		1.00 min/day	62 days	100 Lab Supervisor		
	Bacteriology		1.00 min/day	62 days	100 Lab Supervisor		1.00 min/day	62 days	100 Lab Supervisor		
	Coagulation		1.00 min/day	62 days	100 Lab Supervisor		1.00 min/day	62 days	100 Lab Supervisor		
	B Chemistry		1.00 min/mo	3 mo	100 Lab Supervisor						
	Special Chemistry		1.00 min/mo	3 mo	100 Lab Supervisor						
	Stat Laboratory		1.00 min/mo	3 mo	100 Lab Supervisor						
	Hematology		1.00 min/mo	3 mo	100 Lab Supervisor						
	Bacteriology		1.00 min/mo	3 mo	100 Lab Supervisor						
	Urinalysis		1.00 min/mo	3 mo	100 Lab Supervisor						
	Coagulation		1.00 min/mo	3 mo	100 Lab Supervisor						
						Total 5.52				Total 4.13	1.40 Lab Supervisor

*Frequency that would have been required to process the number of tests requested in period Y.

†Net cost is for January, February, and March 1976.

‡Only those internal laboratory reports affected by AFCLAS.

§NCOIC is the Noncommissioned Officer in Charge of the clinical laboratory.

TABLE III-2
RESULTS OF TIME STUDIES—Continued

Task Number	Task Description	Associated Hypotheses (Appendix G)	Period X				Period Y				Net Cost of AFCLAS (Work Hours Per Quarter, by Personnel Category)†
			Activity Time	Adjusted Frequency for Period X*	Percentage of Time for Each Personnel Category	Hours Worked by Personnel Category	Activity Time	Frequency for Period Y	Percentage of Time for Each Personnel Category	Hours Worked by Personnel Category	
4	Filing Quality Control Reports	6	The time observed in the performance of this task was small (See Task 4 period X, Appendix C) and hence is not reported.				This task was not changed by AFCLAS.				0.00
5	Other Laboratory Filing Tasks	6	All tasks observed in period X were continued in period Y.								
	A Environmental Survey		5.00 min/wk	13 wk			5.00 min/wk	13 wk			
	B Communicable Disease Report		5.00 min/wk	13 wk			5.00 min/wk	13 wk			
	C Antibiogram Report		15.00 min/mo	3 mo			15.00 min/mo	3 mo			
	D Positive Beta Strep		1.00 min/day	62 days			1.00 min/day	62 days			
					60 Lab Supervisor *40 Lab Technician*	Total 3.95			60 Lab Supervisor 40 Lab Technician	Total 3.95	
	E Report of Patients										
	Daily		Task not done in period X				2.00 min/day	62 days	*100 NCOIC*		
	Monthly		Task not done in period X				2.00 min/mo	3 mo	100 NCOIC		
	F Discharge Cumulative Reports		Task not done in period X				5.00 min/day	—	—		
										Total 2.17	2.20 NCOIC
							Note: Filing tasks inside the AFCLAS Computer Room by the computer operators were included in the time to staff the Computer Room.				
6	Removing Outdated Items from Laboratory Files (Move Report Slips from Sections to Central File)	6	This task did not exist in period Y.								
	Chemistry		15.00 min/mo	3 mo							
	Stat Laboratory		15.00 min/mo	3 mo							
	Special Chemistry		15.00 min/mo	3 mo							
	Hematology		15.00 min/mo	3 mo							
	Bacteriology		15.00 min/mo	3 mo							
	Urinalysis		15.00 min/mo	3 mo							
					100 Lab Technician	Total 4.00					–4.00 Lab Technician

*Frequency that would have been required to process the number of tests requested in period Y.

†Net cost is for January, February, and March 1976.

TABLE III-2
RESULTS OF TIME STUDIES—Continued

Task Number	Task Description	Associated Hypotheses (Appendix G)	Period X				Period Y				Net Cost of AFCLAS (Work Hours Per Quarter, by Personnel Category)†
			Activity Time	Adjusted Frequency for Period X*	Percentage of Time for Each Personnel Category	Hours Worked by Personnel Category	Activity Time	Frequency for Period Y	Percentage of Time for Each Personnel Category	Hours Worked by Personnel Category	
7	Filing Outpatient Reports in Outpatient Medical Records (OMR)	7	Note: Of the 48,800 outpatient slips, 85% were filed in OMR.								
			1.023 min for each slip filed	41,480 slips filed		707.23	1.00 min for each page of report.	46,800 pages		780.00	
			0.380 min for each slip not filed	7,320 slips not filed		46.36	The processing and filing of Discharge Cumulative Reports was not 100% in period Y.				
							Estimated time to file Discharge Cumulative Reports was 25% of time to file Daily Reports.			195.00	
					100 OMR Staff	Total 753.59			100 OMR Staff	975.00	221.40 OMR Staff
8	Filing Inpatient Reports	8	Note: Of the 23,800 inpatient slips, 19,800 were filed on the wards; and 4,000 were filed in Inpatient Medical Records.				Note: Of the 22,800 pages of inpatient reports, 19,000 were filed on the wards and 3,800 were filed in Inpatient Medical Records.				
	A. Wards		0.457 min/slip	19,800 slips	50 Nurse 50 Corpsman	75.41 75.41	0.32 min/page	19,000 pages	30 Nurse 70 Corpsman	33.78 67.55	
			5.50 min/day for misc. inpatient filing tasks	90 days	50 Nursing Staff 50 Corpsman	4.13 4.13	0.23 min/report	10,400 reports	30 Nurse 70 Corpsman	13.29 26.58	
	B. Inpatient Medical Records (IMR)		65.30 min/day	62 days	100 IMR Staff	67.47	Filing Daily Reports: 62.00 min/day	62 days	100 IMR Staff	64.07	
							Filing Discharge Cumulative Reports: 2.00 min/report	2,232 admissions	100 IMR Staff	74.40	
					Nursing Staff Corpsman IMR Staff	Total 79.54 Total 79.54 Total 67.47			Nursing Staff Corpsman IMR Staff	Total 47.07 Total 94.13 Total 138.47	32.50 Nursing Staff 14.60 Corpsman 71.00 IMR Staff

*Frequency that would have been required to process the number of tests requested in period Y.

†Net cost is for January, February, and March 1976.

TABLE III-2
RESULTS OF TIME STUDIES—Continued

Task Number	Task Description	Associated Hypotheses (Appendix G)	Period X				Period Y				Net Cost of AFCLAS (Work Hours Per Quarter, by Personnel Category)†
			Activity Time	Adjusted Frequency for Period X*	Percentage of Time for Each Personnel Category	Hours Worked by Personnel Category	Activity Time	Frequency for Period Y	Percentage of Time for Each Personnel Category	Hours Worked by Personnel Category	
9	Preparing and Filing Cumulative Summaries	55	This task included written summaries and mental summaries. Preparing a flow sheet on Form HW 78 or a narrative summary in the progress notes constituted a written summary. A sample of physicians estimated that written summaries are prepared for 15% of the patients and take an average of 13 min each to prepare. Physicians estimated that mental summaries are prepared for 30% of the patients and take a total of 5 min each to prepare.				Special Cumulative Reports were available upon request but were not routinely printed. In addition the phsycians continued to produce manual flow sheets at about the same frequency as in period X. Physicians appear to have more information in period Y, but they expend the same total time as in period X.				
	A Written Summaries		13.00 min/patient	335 Patients	100 Physicians	72.58					
	B Mental Summaries		5.00 min/patient	670 Patients	100 Physicians	55.83 Total 128.41				Total 128.41	0.00 Physicians
10	Filling Out Request Slips or Filling Out Computer Request Cards and Admit Cards	9, 51									
	A Outpatient Request Cards		1.319 min/slip	48,800 slips	10 Clinic Staff 90 Patients	107.28 Clinic Staff 965.51 Patients	0.71 min/card	37,600 Cards	100 Clinic Staff 0 Patients	444.93 Clinic Staff	337.70 Clinic Staff -965.50 Patients
	B Inpatient Request Cards		0.33 min/slip	23,800 slips	100 Nursing Staff	130.90 Nursing Staff	0.71 min/card	18,300 Cards	100 Nursing Staff	216.55 Nursing Staff	85.60 Nursing Staff
	C Admit Cards for Outpatients						0.93 min/card	2,200 Cards	100 Admissions and Dispositions (A&D) Staff	34.10 A&D Staff	34.10 A&D Staff
	D Admit Cards for Inpatients						0.93 min/card	34,600 Cards	100 Clinic Staff	536.30 Clinic Staff	536.30 Clinic Staff
11	Completing Laboratory Request Slips or Cards within the Laboratory	9	2 min/slip	450 slips	40 Receptionist 60 Lab Technician	6.00 Receptionist 9.00 Lab Technician	The usual practice is for the receptionist to instruct the patient to return to the originating clinic to have clinic personnel complete the cards.			Total 0.00	-6.00 Receptionist -9.00 Lab Technician

*Frequency that would have been required to process the number of tests requested in period Y.

†Net cost is for January, February, and March 1976.

TABLE III-2
RESULTS OF TIME STUDIES—Continued

Task Number	Task Description	Associated Hypotheses (Appendix G)	Period X				Period Y				Net Cost of AFCLAS (Work Hours Per Quarter, by Personnel Category)†
			Activity Time	*Adjusted* Frequency for Period X*	*Percentage of Time* for Each Personnel Category	Hours Worked by Personnel Category	Activity Time	Frequency for Period Y	Percentage of Time for Each Personnel Category	Hours Worked by Personnel Category	
12	Entering Results on Slips or Report Cards and CRT Entry of Results	9, 13, 14, 18, 19, 29	0.05 min/test for all tests except Complete Blood Count (CBC)	181,200 tests		151.00	In period Y this task includes: 1) entering results on cards into the AFCLAS system 2) entering results into AFCLAS on CRT and verification during entry.				
			0.02 min/test for CBC (These figures are based on the assumption that the HYCEL 17 is operational.)	11,400 tests		3.80	Note: Task 18 contains time for verification done as a separate step.				
	Hematology (Morphology Differential)						0.50 min/card	10,300 cards		85.83	
	Stat Laboratory						0.523 min/card	4,000 cards		34.87	
	Manual and Special Chemistry						1.03 min/card	2,500 cards		42.92	
	Coagulation						0.78 min/card	2,300 cards		29.90	
	Urinalysis						0.92 min/card	10,800 cards		165.60	
	Microbiology/Bacteriology						1.03 min/card	15,800 cards		271.23	
					100 Lab Technician	Total 154.80			100 Lab Technician	Total 630.35	475.60 Lab Technician
13 14 & 15	Completing Worksheets	9, 13, 14, 29					Production of AFCLAS worksheets was included in the time to run the system by computer operators.				
	Note: Only worksheets eliminated by AFCLAS are shown.										
	A Urine Log		0.74 min/line	4,500 lines		55.50					
	B HYCEL 17 Manual Load List		1.12 min/patient	6,400 Patients		119.47					
					100 Lab Technician	Total 174.97				Total 0.00	175.00 Lab Technician
	Note: See Task 22 for tests related to elimination of the CREATE system.										

*Frequency that would have been required to process the number of tests requested in period Y.

†Net cost is for January, February, and March 1976.

TABLE III-2
RESULTS OF TIME STUDIES—Continued

Task Number	Task Description	Associated Hypotheses (Appendix G)	Period X				Period Y				Net Cost of AFCLAS (Work Hours Per Quarter, by Personnel Category)†
			Activity Time	Adjusted Frequency for Period X*	Percentage of Time for Each Personnel Category	Hours Worked by Personnel Category	Activity Time	Frequency for Period Y	Percentage of Time for Each Personnel Category	Hours Worked by Personnel Category	
16	Labeling Blood Collection Tubes	11	0.233 min/tube	60,100 tubes	100 Lab Technician	233.39	0.50 min/tube	60,100 Tubes	100 Lab Technican	500.83	267.40 Lab Technican
							In period Y this task also included attaching one label on old CBC slip for use with the Coulter Model S.				
17	Preparation for Inpatient Ward Rounds	12	15 min/day	90 days	100 Lab Technician	22.50	22.50 min/day	90 days	100 Lab Technician	33.75	11.30 Lab Technician
18	Supervisors' and Technicians' Review and Certification of Test Results	20, 21									
	Chemistry		0.10 min/slip	22,400 slips		37.33					
	Hematology		0.25 min/slip	14,900 slips		62.08					
	Bacteriology		0.20 min/slip	14,500 slips		48.33	0.17 min/patient	16,000 Patients		45.33	
	Serology		0.20 min/slip	5,700 slips		19.00					
	Parasitology		0.20 min/slip	700 slips		2.33					
	Automated Chemistry						0.29 min/patient	7,100 Patients		34.32	
					100 Lab Supervisor	Total 169.07			100 Lab Supervisor	Total 79.65	89.40 Lab Supervisor
19	Performing Statistical Analysis of Quality Control	22, 23, 24	The activities observed for this task are described in Appendix B. Since AFCLAS did not change the way this task was performed, the times are not summarized.				Since this task did not change from period X, it was not time studied in period Y.				0.00
20	Performing Statistical Analysis of Patient Results by Population	25, 26	There is no evidence that this task was performed in period X.			0.00	There is no evidence that this task was performed in period Y.			0.00	0.00
21	Performing Test Result Calculations or Conversions	27	The activities observed for this task are described in Appendix B. Since AFCLAS did not change the way this task was performed, the times are not summarized.				The Technicon Stat Ion introduced in the *Stat* Laboratory eliminated some of the conversion tasks performed in period X.				0.00

*Frequency that would have been required to process the number of tests requested in period Y.

†Net cost is for January, February, and March 1976.

TABLE III-2
RESULTS OF TIME STUDIES—Continued

Task Number	Task Description	Associated Hypotheses (Appendix G)	Period X				Period Y				Net Cost of AFCLAS (Work Hours Per Quarter, by Personnel Category)†
			Activity Time	Adjusted Frequency for Period X*	Percentage of Time for Each Personnel Category	Hours Worked by Personnel Category	Activity Time	Frequency for Period Y	Percentage of Time for Each Personnel Category	Hours Worked by Personnel Category	
22	Computer Operations Related to the CREATE System‡	28					This task was eliminated by AFCLAS.				
	A Automated and Manual Chemistry		0.39 min/slip	22,400 slips		145.60					
	B Tests Not Done on the HYCEL 17		0.05 min/slip	5,600 slips		4.67					
	C Master Worksheets		0.11min/patient	12,900 Patients		23.65					
	D Compilation of Daily Totals		2.41 min/day	62 days		2.49					
	E Monthly Totals		5.33 min/mo	3 mo		0.27					
					100 Lab Technician	Total 176.68				0.00	-176.70 Lab Technician
23	Calling a Ward or Clinic to Report the Results of *Stat* Test (Includes only calls originating in *Stat* Lab, Hematology, and Urinalysis)	56	Laboratory policy during both period X and period Y was that all *Stat* results are telephoned to the ward or clinic. As reported in Appendix C, some differences between period X and period Y were observed, but it is probable that changes were a result of intervening factors rather than the introduction of AFCLAS.				No net change from period X.				0.00
24	Supervisors (Laboratory Officers) Responding to Inquiries, Complaints, and Errors	53	Problems were tracked down but based on observation, it appeared that this task was done by laboratory technicians rather than laboratory officers. Some small changes occurred between period X and period Y, but it is probable that changes were a result of intervening factors rather than the introduction of AFCLAS.				No net change from period X.				0.00
25	*Processing Inquiry Telephone* Calls to the Clinical Laboratory	2, 3, 4	2.05 *min/call*	3,739 calls	100 Lab Technician 100 Nurse	127.75 127.75	2.10 min/call	2,567 Calls	100 Lab Technician 100 Nurse	89.84 89.84	-37.90 Lab Technician -37.90 Nursing Staff
26	Retrieval of Data to Answer Inquiries That Required a Return Call Plus Time to Complete Return Call	3									
	A Chemistry		15.00 min/inquiry	52 inquiries		13.00	This task was eliminated by AFCLAS.				
	B Hematology		15.00 min/inquiry	39 inquiries		9.75					
	C Bacteriology, Serology, and Parasitology		3.00 min/inquiry	78 inquiries		3.90					
					100 Lab Technician	Total 26.65					-26.70 Lab Technician

*Frequency that would have been required to process the number of tests requested in period Y.

†Net cost is for January, February, and March 1976.

‡CREATE is a time sharing computer system at Wright Patterson AFB. It was used by the Chemistry section to generate worksheets during period X.

TABLE III-2
RESULTS OF TIME STUDIES – Continued

Task Number	Task Description	Associated Hypotheses (Appendix G)	Period X				Period Y				Net Cost of AFCLAS (Work Hours Per Quarter, by Personnel Category)†
			Activity Time	Adjusted *Frequency* for Period X*	Percentage of Time *for Each* Personnel Category	Hours Worked per Personnel Category	*Activity Time*	Frequency for Period Y	Percentage of Time *for Each* Personnel Category	Hours Worked per Personnel Category	
27	Reviewing or Processing New AFCLAS-generated Reports Unfinished Work Reports: Chemistry *Stat* Laboratory Hematology Coagulation Bacteriology, Serology, and Parasitology Urinalysis	58	This task was not performed during period X.				 3.00 hr/wk 2.00 hr/wk 4.00 hr/wk 1.50 hr/wk 4.00 hr/wk 1.00 hr/wk	 13 wk 13 wk 13 wk 13 wk 13 wk 13 wk	 100 Lab Technician	 39.00 26.00 52.00 19.50 52.00 13.00 Total 201.50	201.50 Lab Technician
28	Addition of Cytology to the AFCLAS Reporting System	14	This task was not performed during period X.				Considered only those new tasks performed in period Y by the Cytology technician that were in addition to the tasks performed in period X. 1.62 min/patient 30.00 min/day for processing unfinished work reports	 3,000 Patients 62 days	 100 Lab Supervisor	 81.00 31.00 Total 112.00	112.00 Lab Supervisor
29	Preparing a List of Admissions, Discharges, and Interward Transfers for Lab Use (This was done in A&D using the MAMS-R system.)	57	This task was not performed during period X.				0.25 min/transfer	5,100 transfer	100 A&D Staff	21.25	21.30 A&D Staff
30	Total Outpatient Time in the Clinical Lab	37	18.90 min/visit	14,000 visits	100 Patient	4,410.00	31.00 min/visit	14,000 visits	100 Patient	7,396.67	2,986.70 Patients
31	Impact of AFCLAS Downtime on Laboratory Operation	28, 40	This task was not performed during period X.				The majority of the downtime occurred during end-of-day processing between 2300 hours and 0700 hours. The downtime was an inconvenience to the computer operator, but the lost time is included in the time required to operate AFCLAS. There were significant problems with terminal equipment located in the reception area. The time lost is included in the time to perform the reception function. The time lost by laboratory technicians due to downtime is small and hence is ignored.				0.00

*Frequency that would have been required to process the number of tests requested in period Y.

†Net cost is for January, February, and March 1976.

TABLE III-3

SUMMARY OF PERSONNEL WORKHOURS PER QUARTER
FOR TASKS TIME STUDIED

Personnel Category*	Net Change in Hours per Quarter †
Clinic Staff	874
Laboratory Technician	506
Outpatient Medical Records (OMR) Staff	221
Inpatient Medical Records (IMR) Staff	71
Admissions and Dispositions (A&D) Staff	55
Ward Nurse	15
Corpsman	15
Laboratory Officer	- 3
Laboratory Supervisor	- 10
Noncommissioned Officer in Charge (NCOIC) of Laboratory	- 16
Patient	2,021
Staff Total	1,728
Patient Total	2,021

* A negative 6 hours per quarter for the receptionist is included in the times shown in Table IV-1.

† Values given are based on workload for January, February, and March 1976.

C. Personnel Cost Rates

For each personnel category, we first determined the number of personnel at each rank or GS grade in the category. Next we calculated the average cost for the personnel category by computing a weighted average of the direct cost to the Air Force for all personnel in the category. We based military personnel rates on the Air Force Annual Composite Standard Rate, and we based Civil Service personnel rates on 108.44 percent [Ref. 2] of Step 4 of the GS pay scale, both as of 1 October 1975. We then calculated the hourly and quarterly rates for each category from the annual rate. The results are summarized in Table III-4. The details of the calculation are contained in Appendix B.

TABLE III-4

PERSONNEL COST RATES

Personnel Category	Hourly Rate	Quarterly Rate	Annual Rate
Laboratory Officer	$13.24	$5,719	$22,876
Ward Nurse	9.40	4,062	16,247
NCOIC of Laboratory	9.43	4,073	16,291
Laboratory Supervisor	9.12	3,939	15,756
Laboratory Technician	6.17	2,667	10,667
IMR Staff	5.51	2,379	9,515
Clinic Staff, A&D Staff	5.23	2,258	9,031
OMR Staff, Corpsman	4.21	1,819	7,275
Patient	0	0	0

D. Net Cost For Tasks Time Studied

Table III-5 lists by personnel category the direct dollar savings and costs associated with the tasks that we examined using time studies. The quarterly direct dollar saving and costs are computed by multiplying the net times in Table III-3 by the hourly personnel rates given in Table III-4.

The projected annual cost of staff tasks increased by $36,899. When we include an allowance factor of 11.6 percent for unproductive time (the factor normally used in MET studies), the total increase in annual costs for the staff tasks is projected to be $41,179.

TABLE III-5

PERSONNEL COST OF TASKS TIME STUDIED

Personnel Category	Net Change in Hours per Quarter*	Quarterly Cost	Projected Annual Cost
Clinic Staff	874	$4,571	$18,284
Laboratory Technician	506	3,122	12,488
OMR Staff	221	930	3,722
IMR Staff	71	391	1,565
A & D Staff	55	288	1,151
Ward Nurse	15	141	564
Corpsman	15	63	253
Laboratory Officer	- 3	- 40	- 159
Laboratory Supervisor	- 10	- 91	- 365
NCOIC of Laboratory	- 16	- 151	- 604
Patient	2,021		
Staff Total	1,728	$9,224	$36,899
Patient Total	2,021		
Total			$41,179†

* Values given are based on workload for January, February, and March 1976 (see Table III-3).

† Reference 2 specifies an allowance factor of 11.6 percent for unproductive time.

REFERENCES

(1) U.S. Department of the Air Force. AFM 25-5—Management Engineering Policies and Procedures. Washington, D.C.: Headquarters U.S. Air Force, August 1973.

(2) U.S. Department of the Air Force. AFM 26-1—Manpower Policies and Procedures. Washington, D.C.: Headquarters U.S. Air Force, May 1973.

IV. RECEPTIONIST AND COMPUTER-RELATED TASKS

AFCLAS created new tasks for the receptionists and new tasks directly related to management and operation of the computer system. We did not time study these tasks because they require that personnel be fully committed to them, whether or not the personnel are fully utilized. Table IV-1 at the end of this chapter summarizes the total annual cost for new receptionist and computer-related tasks.

A. AFCLAS System Manager

A computer system of even moderate size requires management attention and creates new management tasks. At MCWP the management tasks created by AFCLAS were performed on a part-time basis by the following personnel: Chairman of the Department of Pathology, AFCLAS Systems Manager, NCOIC of the clinical laboratory, and personnel in the Medical Computer Systems Office. While the total time expended by all the personnel exceeded one full-time equivalent, it is probable that the majority of the tasks could be perfomed by one carefully selected officer designated as AFCLAS System Manager and devoted entirely to AFCLAS. This new full-time position would be in addition to the number of laboratory officers authorized to operate the laboratory and required to insure proper test processing. The position of AFCLAS Systems Manager could be filled by a captain (O-3) or a major (O-4); hence it has been costed at $20,751, the planning factor for a captain.

B. Data Base Maintenance and Routine Administration

For effective operation, the AFCLAS-configurable files need to be continually updated, and administrative matters such as the ordering of computer supplies require daily attention. During period Y at MCWP a staff sergeant (E-5)

performed this task working half-time. Since the annual composite standard rate for a staff sergeant is $10,550, a half-time position was costed at $5,275.

C. Computer Room Staff

Because of the size and complexity of AFCLAS, the computer room must be manned 24 hours a day, 7 days a week. According to the manning standards of the MET, this requires a mininum of five military personnel. However, it is probable that the computer room staff could assume additional duties if the policies of the Air Force Logistics Command and the hospital were changed. As derived in Appendix B, Section N, the annual cost to staff the computer room is $49,979.

During period Y more than five people were assigned in the laboratory as computer operators, which was in part due to a special situation at WPAFB. A reduction in force for computer operators at the Air Force Logistics Command (AFLC) was in progress, and a number of AFLC operators were temporarily assigned to the laboratory at WPAFB. The number of computer operators in the laboratory for AFCLAS should stabilize at five or six.

D. Reception Personnel

The installation of AFCLAS added several new tasks to duties of the receptionists as follows:

- Darken the marks on test request and admit cards
- Enter request cards into AFCLAS system
- Correct any cards that could not be read by the AFCLAS system
- Verify patient demographic data
- Collate request cards with draw labels.

In order to perform the new AFCLAS-related tasks an additional two and one-half full-time equivalent receptionists would be required. This estimate was made based on direct observation by the MET during period Y. As derived in Appendix B, Section N, the annual increase in cost for

receptionists was $22,223.

During period Y, the reception area was staffed by three full-time receptionists during the day, one full-time receptionist during the evening, and laboratory technicians half-time on Saturday and on Sunday. This staffing was required since the laboratory workload in the evening increased between period X and period Y because the Primary Care Clinic began operating during the evening. Also we observed that the receptionists seemed to provide a higher level of service during period Y while performing all the duties performed in period X. While the staffing in the reception area was increased considerably, only two and one-half full-time equivalents can be attributed to AFCLAS.

The additional cost for an AFCLAS Systems Manager, data base maintenance and routine administration, computer room staff, and reception personnel is summarized in Table IV-1.

TABLE IV-1

ADDITIONAL PERSONNEL COST FOR RECEPTIONISTS AND COMPUTER-RELATED TASKS

Personnel Added	Number of Persons	Projected Annual Cost
Computer Room Staff	5.0	$49,979
Reception Personnel	2.5	22,223
AFCLAS Systems Manager	1.0	20,751
Data Base Maintenance and Routine Administration	0.5	5,275
Total	9.0	$98,228

V. SUMMARY OF DOLLAR BENEFITS AND COSTS

In this chapter direct costs of AFCLAS for hardware rental, software rental, paper forms and computer supplies, and electric power are first derived, and then all dollar benefits and costs including personnel costs are summarized.

A. Hardware Charges

The contract with the vendor of the AFCLAS system specified that the Air Force had the option either to purchase the system or to lease it. The Air Force chose to lease the system (both hardware and software) under a leasing arrangement that included the following provisions:

- Preventive maintenance performed by the vendor whenever it is needed
- Unlimited, 2-hour response, on-call maintenance performed by the vendor during the Principal Period of Maintenance (PPM) (0600 hours - 1900 hours, Monday through Friday)
- $45 per hour for maintenance outside PPM (FY 75 through FY 77). This was estimated by ANSER to be $1,000 per year.
- No additional charges for replacement parts, unless such parts are required due to fault or negligence by the government.

The lease price for the configuration at MCWP during April 1976 was $15,304 per month or $183,648 annually.

B. Software Charges

The lease charges for software include the following: software configuration, test and integration, file structure and general site customization, acceptance testing, documentation training, and routine software support. The lease price for software for MCWP is $1,851 per month or $22,212 annually.

It is important to note that the software cost of $22,212 per year was not expended during period Y due to a contractual technicality, but it will be a cost in the near future. Since we estimated the expected cost of operating AFCLAS, the software cost of $22,212 is included even though it was not expended.

C. Paper Forms and Computer Supplies

In this section the net cost of paper forms and computer supplies is calculated by estimating the cost of computer paper and computer supplies used in period Y, and then subtracting the cost of forms used during period X.

Computer supplies include AFCLAS request cards, admit cards, labels, disk packs, magnetic tapes, printer ribbons, teletype paper, and miscellaneous forms exclusive of two-part paper for patient reports. The contract specifies the cost of computer supplies, expected to last 1 year, to be $108,660. This figure is high since it includes several startup costs that will not be included in future systems. Also the cost of labels and mark-sense cards has decreased on the open market so the vendor has since decreased the price in order to be competitive. After consultation with the vendor and with TRIMIS Program Office (TPO) personnel, a reasonable price for computer supplies was estimated to be $23,500 per year.

Between 1 October 1975 and 1 October 1976, approximately 891,000 two-part forms (pages) were used for printing patient reports. At a cost of $0.0112 per form, the total cost of two-part report forms was $10,000.

We estimated the cost of paper forms used in period X as follows:

14,913 Hematology slips x $0.0170 each	$254
14,051 Urinalysis slips x $0.0081 each	114
43,654 other slips x $0.0057 each	249
Printing 1,000 copies each of 20 local forms	350
Miscellaneous log books	33
	$1,000

In summary, the net yearly cost of computer supplies and paper forms was as follows:

Computer Supplies (Period Y)	+ $23,500
Two-Part Patient Report Forms	+ 10,000
Paper Forms Used (Period X)	- 1,000
Total	$32,500

D. Electric Power

The cost of electric power includes electricity to run the computer, electricity for peripherals outside the computer room, and electricity for operating the computer room air conditioner. As derived in Appendix H, total electricity cost was $3,356 per year.

E. One-Time Cost

The one-time cost of installing AFCLAS is for site preparation and shipping and installation of AFCLAS. Site preparation included modification of the X-ray reading room into a computer room, purchase and installation of an air-conditioning system, and installation of all necessary wiring for remote peripherals. The one-time cost can be broken down as summarized below:

Site Preparation	$48,366
AFCLAS Installation	36,055
Supplies for Initial Operation	5,500
Shipping for Computer Equipment	1,710
Total	$91,631

F. Summary of Dollar Benefits and Costs

At MCWP, the total expected dollar cost (including all of the dollar savings) of operating AFCLAS (as configured in April 1976) was $382,123 per year more than that required to operate the previous manual system. In addition, there was a one-time cost of $91,631. The recurring cost breaks down as follows:

Hardware Yearly Lease	$183,648
Maintenance Outside PPM	1,000
Software Yearly Lease	22,212
Net Yearly Cost for Paper Forms and Computer Supplies	32,500
Electric Power	3,356
Net Personnel Costs for Tasks Time Studied (Chapter III)	41,179
Net Personnel Costs for Receptionists and Computer-Related Tasks (Chapter IV)	98,228
Total	$382,123

Again note that the software cost of $22,212 per year was not expended during period Y.

VI. ACCEPTANCE, SATISFACTION, AND IMPROVEMENTS TO AFCLAS SUGGESTED BY HOSPITAL STAFF

The measure of effectiveness of a technological change such as AFCLAS is more than conformity to design specifications. AFCLAS had an effect upon physicians, registered nurses, laboratory staff, and other hospital staff because it changed the way they performed some of their tasks. The acceptance of AFCLAS by hospital personnel determined how well technical capability was converted into operational capability. The relationship between patient satisfaction and the effectiveness of AFCLAS is not as clearly evident as the relationship between the acceptance of AFCLAS by hospital personnel and the effectiveness of AFCLAS, but we assumed that some relationship existed. With respect to acceptance, we made the assumption that AFCLAS affected each category of hospital staff differently. It seemed reasonable to expect that the impact of AFCLAS as perceived by the hospital staff was a function of the degree to which AFCLAS changed the way daily tasks were performed and the significance of the tasks.

The phenomenon of resistance to innovation or change, called *cultural lag*, was an important factor affecting the acceptance of AFCLAS by physicians and other categories of hospital staff. The basic concept of *cultural lag* is attributed to William Ogburn and is well documented in the sociological literature [Refs. 1, 2, and 3]. This literature, as well as the evaluation by Battelle of Technicon's hospital information system implemented at El Camino Hospital [Ref. 4], suggests that physician, nurse, and other hospital staff acceptance and enthusiasm for AFCLAS would be limited because of the short time interval between adequate functional operation of AFCLAS in January 1976 and the administration of the questionnaires in April 1976. Further, the Battelle study indicated that

physicians' acceptance would continue to increase for several years after installation of a medical information system.

This chapter describes the results of interviews and questionnaires administered to measure acceptance or satisfaction with AFCLAS and the clinical laboratory. We measured physician satisfaction with the laboratory, physician acceptance of AFCLAS, registered nurse acceptance of AFCLAS, job satisfaction of laboratory staff, patient satisfaction with the laboratory, and acceptance of AFCLAS by other hospital staff. Suggestions by each category of personnel for improving AFCLAS are presented as part of the discussion of acceptance and satisfaction. Appendix D summarizes the data for scoring the physician and registered nurse questionnaires, and Appendix E contains copies of the period Y version of all the questionnaires.

A. Physicians

In March 1975, prior to installation of AFCLAS, the physicians completed a forced-choice written questionnaire on the clinical laboratory system at the Medical Center and on their acceptance of the AFCLAS concept. In April 1976, about 6 months after AFCLAS was accepted by the Air Force,* the physicians completed another forced-choice written questionnaire on the clinical laboratory system at the Medical Center and their acceptance of AFCLAS. The questionnaire administered in period Y differed from the questionnaire in period X only in the tense of the verbs. During the fourth week of June 1976, about 8 months after AFCLAS became operational at the Medical Center, a sample of 25 physicians was interviewed at the Medical Center to obtain further insight into the physicians' perceptions of AFCLAS.

*AFCLAS was not functionally operational until the end of January 1976.

In addition to AFCLAS, another new computer system, Medical Administrative Management System-Revised (MAMS-R), and several pieces of automated laboratory equipment were introduced into MCWP between March 1975 and April 1976. MAMS-R is a computer system designed both to record outpatient workload using a mark-sense encounter form and to maintain inpatient information entered through an online CRT. The HYCEL-17 and the Technicon Stat Ion are both automated blood chemistry autoanalyzers that became operational in the late spring of 1975. The HYCEL-17 appeared to have had significantly more impact than the Technicon Stat Ion on the operation of the laboratory and on users of laboratory results.

It would be extremely difficult to estimate the influence of these subsystems upon the response to the written schedule or to the interview. The physicians interviewed mentioned these systems and noted that they were not part of AFCLAS, but many went on to identify HYCEL-17 and MAMS-R problems. In many cases, it was difficult for the physician to know whether a delayed report was due to AFCLAS or the HYCEL-17. Several physicians mentioned the burden MAMS-R placed upon support people in the clinics. We omitted from the analysis of the responses to interviews presented below direct references by the respondents to the HYCEL-17 and MAMS-R. However, the possibility that MAMS-R and HYCEL-17 may have contaminated the results should be considered in drawing conclusions from the analysis.

In Subsection 1 the information obtained from interviews with physicians is summarized, and in Subsection 2 the results of analyzing the responses to the physician questionnaire are presented.

1. Physician Interviews

The methods for conducting the physician interviews are first summarized and then followed by a discussion of the results. We obtained the names of all physicians assigned to the Medical Center and deleted from the list all physicians in aeromedical services, occupational medicine (located in Building 40), pathology, and radiology. The final list contained 121 physicians. A random sample of 25 physicians on duty at the Medical Center or Building 40 during the fourth week in June was selected, and appointments were scheduled for the physicians to meet with the interviewer. We conducted the interviews in an office located in the administrative wing of the hospital, such that the setting for the interview was tastefully furnished and completely private. Only the interviewer and the individual respondent were in the office during the interview. The respondents were assured of the impartiality of the interviewer and of their own anonymity. In the analysis below respondents are identified by numbers randomly assigned after all the interviews were completed. Thus, the numbers assigned do not represent the order in which respondents were interviewed.

All 25 physicians in the sample were interviewed. The time taken for an interview ranged from 15 minutes to 1 hour and 40 minutes, with an average time of about 40 minutes. Five open-ended questions were asked each respondent during the interview. Responses to each question are analyzed in separate sections below. We used nondirective probing after the initial question to avoid any possibility and appearance of interviewer bias.

There was no evidence during the interviews or in the interview data to suggest that the physicians were inhibited

during the interviews, nor was there any evidence of following an official position on AFCLAS. The comments clearly are not those of a group following a "party line."

Physician's Perception of the Impact of AFCLAS upon Patient Care. The respondents were asked to discuss the impact of AFCLAS on their day-to-day practice in the delivery of health care. Seventeen of the respondents perceived a significant positive effect upon delivery of health care in their day-to-day practices. The reasons are categorized and accumulated in Table VI-1.

The reason cited most often for improved patient care was the cumulative reports generated by the system. Cumulative reports were not available to the physicians at MCWP before the introduction of AFCLAS, but they could generate manually flow sheets of laboratory results. The other reasons listed by the physicians were improvements of the manual system as a result of AFCLAS. Thus it appears that it is the innovative characteristic of AFCLAS that is most frequently cited by physicians as a positive effect upon patient care rather than improvement in provision of services provided under the manual system. The improvements are important. Greater legibility of reports, charts, and records; reduced response time; and fewer lost reports were identified by three or more physicians as impacting patient care. Improved information on the patient and patient identification could be significant but those were cited only once.

The respondents who perceived the positive effects of AFCLAS on patient care also made comments that implied a negative effect on patient care. These are categorized and accumulated in Table VI-2. Five of the respondents perceived no significant effect upon patient care.

TABLE VI-1

NUMBER OF RESPONSES ON EFFECT OF AFCLAS UPON PATIENT CARE BY CATEGORY. RESPONDENTS WHO PERCEIVED POSITIVE EFFECTS OF AFCLAS

Positive Effects	
Response Category	Number of Responses
Cumulative reports	10
Legibility of reports	4
Charts and records	4
Lost reports	4
Turnaround time	3
Patient information	1
Patient identification	1

TABLE VI-2

NUMBER OF RESPONSES ON EFFECT OF AFCLAS UPON PATIENT CARE BY CATEGORY. RESPONDENTS WHO PERCEIVED NEGATIVE EFFECTS OF AFCLAS

Negative Effects	
Response Category	Number of Responses
Stat	3
Bulkier charts	2
Difficulty in obtaining cumulatives	2
Error rate	1
Outside reports don't get into record	1

Three of these respondents explained that they perceived no significant effect because they did not use laboratory reports extensively in their practice. Respondent 18 stated that he seldom used the laboratory; respondent 9 said he did not perceive much impact because utilization of the laboratory was light; respondent 13 said that the laboratory was not of major importance in his specialty. One respondent, respondent 11, who perceived no significant effect, stated there was no direct effect because AFCLAS "doesn't work." Respondent 8 stated categorically that AFCLAS had no significant effect. (This respondent is in a specialty that has a high volume of laboratory work.) It appears from the above comments that although five respondents found no significant effect upon patient care, only one directly attributed this to the system. However, the categorical statement might be attributed to the system since this respondent's specialty is a high volume user of the system. The basis for his statement could also be attributed to factors other than AFCLAS, e.g., personnel.

The three respondents who perceived no significant effect of AFCLAS upon patient care and who stated that they did not use the laboratory extensively added positive statements about AFCLAS. Respondent 9 stated that: the cumulative reports were very good; reports were legible; fewer reports were lost from the record because AFCLAS forms are better than loose slips; information gets into the charts better. Respondent 13 said that cumulative reports are useful. Respondent 18 stated that when he did use the system, he was satisfied.

Three of the respondents perceived a negative effect of AFCLAS upon patient care. Respondent 25 stated that there was an adverse effect on patient care because: specimens are mislabeled; there are multiple reports of tests and, as a result, the physician doesn't know whether these tests are

new tests or duplicate reports of old tests; and there are more lost specimens. It is not clear whether these problems are inherent in AFCLAS or are due to weaknesses in the personnel system or to management procedures. Respondent 12 explained why he believed AFCLAS had a "bad" effect on patient care. He began by saying that patients were used in an experiment--the initial installation of AFCLAS. He further stated that it is difficult for physicians from other facilities to interpret AFCLAS reports; physicians must go over cumulative records to find the kind of information that was color coded before; there are too many cumulative reports; more repeat tests; and physicians are concerned with loss of data if the computer goes down. The above reasons for the adverse effect of AFCLAS upon patient care may be inherent in the system, e.g., loss of data if the computer goes down (it should be added that he did not state that there had been a loss of data). Other reasons may be administrative, and finally, one problem is peculiar to the Wright-Patterson Medical Center, i.e., patients were used in experiments. One of the most emotional responses to AFCLAS was by respondent 16, who stated, "I hate the computer deep down. I wouldn't stay here if they made me a general!" and, "Burn the computer!" The reasons for a negative effect on patient care cited by this respondent were the difficulty in getting test results and delay with *stats*. He said the delay in *stats* was because of paperwork; if something is needed immediately, response time is so slow that it is detrimental to patient care; physicians stand in line in the laboratory to get results before making rounds. The respondent made other comments on AFCLAS, all of which related to delay in getting test results, which he attributed to paperwork. The significance of the respondent's comments on AFCLAS depends upon whether one considers the paperwork required at the Wright-Patterson Medical Center to be an integral part of AFCLAS.

In summary, when all of the responses are considered, 22 of the respondents perceived either a significant positive effect (17) of AFCLAS on patient care or no significant effect (5) as a result of AFCLAS. Of those who perceived no significant effect, only one attributed this directly to AFCLAS; three related the absence of effect to their lack of use of the laboratory; and the categorical response of one physician provided no basis for his reasons for perceiving no significant change. The three respondents who perceived a negative effect of AFCLAS upon patient care gave reasons that cannot be interpreted conclusively as related to AFCLAS rather than to some other part of the total laboratory system.

Physicians' Perception of Improvements in the Laboratory System as a Result of AFCLAS. The respondents were asked what has improved since the introduction of AFCLAS. The question was open ended but the investigation was concerned with obtaining responses related to cumulative reports, turnaround time, retrieval time, and test request forms. The respondents did identify the first three of these, but in rank order of categories by number of responses, turnaround time was sixth and the test request form was ranked eighth (Table VI-3). Physicians mentioned the request forms but in only one case did the physician complete the form himself. The physician who filled out the forms said he found no difficulty. Two physicians said that the request forms were better. The respondents distinguished improvements in patient care after AFCLAS (Table VI-1) from improvements in the laboratory system after AFCLAS (Table VI-3). Cumulative reports ranked first both in response to impact of AFCLAS on patient care and improvements in the laboratory system as a result of AFCLAS. However, retrieval was not mentioned as an effect on patient care, but it ranked second in improvements in the laboratory system due to AFCLAS. Format of reports

TABLE VI-3

NUMBER OF RESPONSES TO QUESTION ON IMPROVEMENTS DUE TO AFCLAS, BY CATEGORY OF RESPONSE AND CATEGORY OF RESPONDENT

Response Category	Total Number of Responses	Respondents Who Perceived a Significant Positive Effect Upon Patient Care	Respondents Who Perceived no Significant Effect Upon Patient Care	Respondents Who Perceived a Significant Negative Effect Upon Patient Care
Cumulative reports	19	13	3	3
Retrieval time	7	3	3	1
Legibility of reports	6	5	1	
Format of reports	5	3	2	
Patient records	4	3		1
Turnaround time	3	3		
Stats	3	3		
Request forms	2	2		
Lost reports	2	2		
Routine reports	1	1		
Error rate	1	1		

was not mentioned in response to impact on patient care but ranked fourth in improvements in the laboratory system as a result of AFCLAS. Legibility ranked high in both impact on patient care (second) and on improvements in the laboratory system due to AFCLAS (third). *Stats* were not mentioned as a positive effect upon patient care but were mentioned by three respondents as an improvement in the laboratory system due to AFCLAS. Twenty-four of the respondents perceived improvements in the laboratory system due to AFCLAS. The one respondent who perceived no improvements in the laboratory system also perceived no significant effect of AFCLAS on patient care. All three of the respondents who perceived a negative effect of AFCLAS on patient care found improvements in the laboratory system due to AFCLAS. The three also perceived the cumulative reports as an improvement in the laboratory system, and one perceived retrieval time as an improvement in the laboratory system.

In summary, almost all of the respondents perceived improvements in the laboratory system that were due to AFCLAS. The specific improvements were somewhat different from those that had a specific effect upon patient care, but cumulative reports and legibility of reports ranked high both in effect upon patient care and in improvements in the laboratory system due to AFCLAS.

Physicians' Perceptions of What has Deteriorated Since Introduction of AFCLAS. Respondents were asked what had deteriorated since AFCLAS became operational. Twenty-three respondents identified some deterioration since AFCLAS. However, the reasons (see Table VI-4) in many cases were not directly related to AFCLAS. Since the study was concerned only with AFCLAS, we eliminated from analysis all comments not directly related to AFCLAS. The difficulty with this

TABLE VI-4

NUMBER OF RESPONSES TO QUESTION ON THE DETERIORATION OF THE LABORATORY SYSTEM AS A RESULT OF AFCLAS, BY CATEGORY OF RESPONSE AND CATEGORY OF RESPONDENT

Response Category	Total Number of Responses	Respondents Who Perceived a Significant Positive Effect Upon Patient Care	Respondents Who Perceived No Significant Effect Upon Patient Care	Respondents Who Perceived a Significant Negative Effect Upon Patient Care
Cumbersome records for inpatients and outpatients	8	4	2	2
Format and color of laboratory requests	8	4	2	2
Reports not filed	6	2	1	3
Turnaround time	5	4		1
Ease of retrieving test results	5	3	2	
Number of lost reports	5	4	1	
Availability of system for results inquiry (called "less downtime")	5	4		1
Turnaround time for *stats*	5	3		2
Lost specimens	4	3		1
Errors in input to computer	3	2		1
Laboratory reports sent to wrong place (outpatient records or inpatient records)	2	2		

approach is that the perception of deterioration due to AFCLAS as well as the perception of the effect of AFCLAS upon patient care is influenced by non-AFCLAS variables. One category of comment made by over one-third of the respondents was what was referred to by some of the respondents as the "people problem." "People problem" was used in a very general sense by respondents and was applied to everyone who participated in the system--from physicians to clerks. It included shortage of staff, resistance to innovation, and lack of training.

Among the respondents who perceived a negative effect of AFCLAS on patient care was respondent 25, who stated, "Human error is the problem" and "The lab hides behind the computer." Respondent 12 said: "The computer is between technician and physician" and "People have not become accustomed to IBM cards." Respondent 13, who perceived no significant effect of AFCLAS upon patient care, said: "It is hard to know what is a personnel problem and what is an AFCLAS problem. Problems of lab might not be related to AFCLAS. Can't blame AFCLAS for lab problems." Another respondent, number 11, who perceived no significant effect of AFCLAS on patient care, said: "Cumulative reports are not working because of people." Of the respondents who perceived a positive effect of AFCLAS upon patient care, four cited the people problem.

It appears from the above that although a high percentage of all respondents identified a people problem, those who perceived a negative effect of AFCLAS upon patient care cited the people problem more frequently than those who perceived a positive effect of AFCLAS on patient care. How much of the deterioration due to the people problem can be attributed to the inherent characteristics of AFCLAS is not readily discernible.

In Table VI-4, categories of response to the above question are listed in rank order of number of responses in each category. The most frequent response is "cumbersome records;" the second most frequent response is "format and color of laboratory requests." It is not obvious whether the size of AFCLAS laboratory report forms makes the record more cumbersome or whether the failure to remove earlier reports when cumulative reports are filed makes the record more cumbersome. Comments of respondents support both possibilities.

The third category of responses listed in Table VI-4, "reports not filed," seems clearly to be a people problem. It is with the fourth category, "turnaround time," that the weight is more clearly toward an AFCLAS problem.

The problem of distinguishing people problems from AFCLAS problems exists in the other categories of response listed in Table VI-4. The number of responses to the categories listed is broken down further to those physicians who perceived a positive effect upon patient care, those who perceived no significant effect upon patient care, and those who perceived a negative effect upon patient care. The average number of responses was highest for those physicians who perceived a negative effect of AFCLAS upon patient care and lowest for those who perceived no significant effect.

In summary, the sample of physicians perceived a number of categories of deterioration since AFCLAS. However, since AFCLAS as a computer-based information processing subsystem was not clearly separated from the total laboratory system by the respondents, what is unequivocally due to AFCLAS cannot be determined.

Physicians' Initial and Subsequent Reaction to AFCLAS.

Physicians were asked their initial reaction to AFCLAS and how their reaction has evolved to the present. The primary objective of the question was to obtain information on the physicians' acceptance of AFCLAS. Twelve respondents referred to the "people problem" in response to this question. As noted in the previous section, the legitimacy of including such responses in the analysis of physicians' perception of AFCLAS and its effects is open to question. Six physicians who had not previously identified the people problem identified it in response to the question referred to above. Of these, four physicians who perceived a positive impact of AFCLAS upon patient care, one physician who perceived no significant impact of AFCLAS upon patient care, and one physician who perceived a negative effect of AFCLAS upon patient care referred to the people problem. Twenty-four physicians responded to the question on their initial and subsequent reaction to AFCLAS. Thirteen respondents remained unchanged in their reaction to AFCLAS. Of these 13, 12 who were initially positive remained positive, and one who was negative remained negative. Two respondents changed from neutral to positive, and four changed from positive to negative (Table VI-5). Slightly over half of the respondents remained unchanged in their reaction to AFCLAS. Of those who changed, four changed to a positive reaction, five to a negative reaction, and two to a neutral reaction.

Seventeen of the respondents discussed the early problems with AFCLAS at MCWP. Their responses are summarized in Table VI-6. Seven of the respondents thought there were early problems but that AFCLAS was better now (at time of interviews); two respondents thought AFCLAS was better in the beginning than now. One respondent who had experience with the initial installation of a computer-based system said that AFCLAS had progressed faster than expected.

TABLE VI-5

PHYSICIANS' INITIAL AND SUBSEQUENT REACTIONS TO AFCLAS, BY CATEGORY AND NUMBER OF RESPONSES IN EACH CATEGORY

Category of Response	Number of Responses
Positive to positive	12
Positive to neutral	2
Positive to negative	4
Negative to positive	2
Negative to negative	1
Neutral to positive	2
Neutral to negative	1
No response	1

TABLE VI-6

NUMBER OF RESPONSES TO QUESTION ON PROGRESS OF AFCLAS FROM TIME OF INSTALLATION TO TIME OF INTERVIEW, BY CATEGORY OF RESPONSE

Response Category	Number of Responses
Early problems, now better	7
Has potential	7
Better when initially installed than now	2
Progressed faster than expected	1

Some comments of respondents who spoke of potential provide a flavor to the responses. Respondent 2 said that "the machine is great and can be more effective than the old system, but has to be fed properly. High potential." Respondent 7 said that it has potential but it has to be given more time to develop. In his words: "It is essential in the long run for a large hospital." Respondent 19 said, "It will be better when it settles down. Fantastic when the bugs are out." Respondent 22 said, "Fantastic potential."

AFCLAS has been generally accepted by the respondents. Eight months after installation most respondents perceived improvements. Many who qualified their acceptance saw a potential for the system. In other words, the system is inherently effective but it will take more time to work out the peripheral problems, e.g., personnel, administrative.

Improvements in AFCLAS That Would Help Physicians. The respondents were asked what improvements in AFCLAS would help them. As in response to other questions, a large number related to the personnel system. Since the question relates to the future of AFCLAS rather than to the past experience with AFCLAS at Wright-Patterson Medical Center, there is more justification for including responses related to personnel in this analysis.

The responses related to personnel are categorized and aggregated in Table VI-7. The response category "better trained people" included comments on the complexity of the computer for laboratory technicians, the need for people to know the total system, and the need for more intensive training for computer operators. The comments refer not to the training of laboratory personnel in their specialty, but rather for working with AFCLAS. The need for "more personnel" was not limited to the laboratory. The category "faster entry of laboratory results into the computer" perhaps relates to better

TABLE VI-7

NUMBER OF RESPONSES TO QUESTION ON WHAT IMPROVEMENTS IN AFCLAS WOULD HELP YOU, BY CATEGORY OF RESPONSE—RESPONSES RELATED TO PERSONNEL

Response Category	Number of Responses
Better trained people	5
More personnel	3
Faster entry of laboratory results into the computer	2
Better selection of laboratory technicians	1
Less personnel turnover	1
Screening old reports from the records	1
Getting tests into the record	1

trained personnel in the sense discussed above. The other comments may be significant but were mentioned only once by the sample of respondents.

The responses that relate directly to AFCLAS rather than the personnel system associated with AFCLAS are categorized and aggregated in Table VI-8. The category cited most often is "more terminals." Two respondents cited the need for video terminals; two for faster response time; one cited a need for faster terminals; and one a need for a backup system. The above appear to be related to system hardware. The remaining comments appear to be related to system software.

It was expected that physicians would identify specific information that a system such as AFCLAS could provide but that is not provided by the present system. This was not the case and perhaps the comment of one respondent that he did not know enough about computers to know what could be done offers some explanation.

2. Physician Questionnaires

The Physician Questionnaire contained two parts (Appendix E). Part 1 measured the physician's knowledge of and personal experience with the clinical laboratory, and Part 2 measured acceptance of AFCLAS and the change (expected change in period X and perceived change in period Y) from a manual to an automated system.

Ninety-six percent of the physicians responded to the questionnaire administered in period X and 93 percent responded in period Y. The numerical value of 1 to 5 was assigned, in order, to score responses from a value of 1 for strongly favorable toward AFCLAS to a value of 5 for strongly unfavorable toward AFCLAS. We computed the mean standard score for the total response to each question as described in the evaluation plan [Ref. 5].

TABLE VI-8

NUMBER OF RESPONSES TO QUESTION ON WHAT IMPROVEMENTS IN AFCLAS WOULD HELP YOU, BY CATEGORY OF RESPONSE

Response Category	Number of Responses
More terminals	7
Better format and color of request forms	3
Simplify getting information	2
Video terminals	2
Better distribution system	2
Faster response time	2
Cumulative reports for week instead of 3 days	2
Capability to change system at local level	2
Less downtime	1
Better patient identification	1
Capability to provide more specific directions to the laboratory	1
Need for a backup system	1
Faster terminals	1
Less spread out reports	1
Cumulative reports for everyone	1
More information on same sheet	1

The overall mean standard score for Part 1 (Questionnaire #1) before AFCLAS was 49.98 and for Part 1 after AFCLAS the mean standard score was 52.11. The overall mean standard score for Part 2 (Questionnaire #2) before AFCLAS was 49.99 and after AFCLAS the mean standard score was 63.33.

The difference for Part 1 between the mean standard score for each of the individual questions for period X and period Y was statistically significant at the 0.001 level for all questions except Question 15, which was statistically significant at the 0.01 level.

The difference for Part 2 between the mean standard score for each of the individual questions for period X and period Y was statistically significant at the 0.001 level for all questions. The direction of change before AFCLAS to after AFCLAS for Part 1 was not consistent. Twenty-seven of the questions were in a negative direction (the standard scores were higher after AFCLAS), and nine were in the positive direction (the standard scores were lower after AFCLAS). The direction of change for all questions in Part 2 was negative.

The positive changes in Part 1 from before AFCLAS to after AFCLAS were in response to Questions 1, 8, 19, 20, 21, 24, 26, 30, and 35. All of these relate to AFCLAS capability.

For the Physician Questionnaire we assumed that responses 1 and 2 to a question implied satisfaction with the laboratory; response 3 implied a neutral feeling; and responses 4 and 5 implied dissatisfaction. Most of the physicians answered all questions in Part 1 of the questionnaire. There were a total of 55 blank responses in period X and 112 blank responses in period Y out of a total of 4,032 possible responses. The first questionnaire measured physician satisfaction with the

clinical laboratory, as follows:

	Period X	Period Y
Satisfied	20%	19%
Neutral	44%	35%
Dissatisfied	36%	46%

The percentage of physicians who were dissatisfied with the clinical laboratory increased by 10 percent from period X to period Y. Information from the interviews with a random sample of physicians indicates that the increase was probably due to intervening factors such as the introduction of the HYCEL-17 that were not introduced by AFCLAS. Table VI-9 shows the results by question.

Part 2 of the questionnaire included "no opinion" as an additional possible response. In period X, most physicians had limited information on AFCLAS so an average of 30 percent of the responses to the individual questions either were "no opinion" or were blank. In period Y, this percentage dropped to 8 percent. The period X version of Part 2 of the questionnaire measured acceptance of the change from a manual to an automated system. The period Y version measured acceptance of AFCLAS after it became operational. The results for the valid responses, omitting "no opinions" and blanks, are as follows:

	Period X	Period Y
Favorable	77%	33%
No change	22%	32%
Unfavorable	1%	35%

Table VI-10 shows the results by question.

TABLE VI-9

PHYSICIAN QUESTIONNAIRE #1

PERIODS X AND Y

Question Number	Period X			Period Y		
	Percent Satisfied	Percent Neutral	Percent Dissatisfied	Percent Satisfied	Percent Neutral	Percent Dissatisfied
1	10	70	20	47	37	16
2	13	39	48	4	27	69
3	18	37	45	6	22	72
4	9	29	62	4	26	70
5	10	55	35	4	35	61
6	9	42	49	10	35	55
7	15	29	56	5	32	63
8	8	16	76	9	21	70
9	14	29	57	6	25	69
10*	-	-	-	-	-	-
11*	-	-	-	-	-	-
12*	-	-	-	-	-	-
13	14	58	28	9	33	58
14†	-	-	-	-	-	-
15	28	28	44	31	26	43
16	21	41	38	16	42	42
17	13	47	40	6	43	51
18	13	41	46	5	23	72
19	8	58	34	12	58	30
20	5	53	42	13	59	28
21	9	73	18	43	38	19
22	49	36	15	38	33	29
23	15	32	53	8	19	73
24	43	31	26	44	33	23
25	38	53	9	38	47	15
26	7	58	35	21	53	26
27	34	29	37	27	30	43
28	53	27	20	34	27	39
29	29	54	17	15	43	42
30	27	58	15	62	25	13
31	8	63	29	5	45	50
32	8	60	32	5	43	52
33	9	53	38	4	34	62
34	58	35	7	29	34	37
35	6	25	69	8	20	72
36	19	70	11	16	71	13
37	35	46	19	28	30	42
Mean	20	45	35	19	35	46

* Percentages were not reported for Questions 10, 11, and 12 because they were designed to gather numerical estimates rather than to ascertain satisfaction with the laboratory.

† Question 14 required only a "yes" or "no" answer. A "no" answer directed the physician to skip Questions 15, 16, and 17.

TABLE VI-10

PHYSICIAN QUESTIONNAIRE #2

PERIODS X AND Y

Question Number	Period X				Period Y			
	Percent Favorable	Percent No Change	Percent Unfavorable	Percent No Opinion or Blank	Percent Favorable	Percent No Change	Percent Unfavorable	Percent No Opinion or Blank
1	83	15	2	28	30	24	46	6
2*	-	-	-	-	22	31	47	8
3	82	18	0	25	54	36	10	6
4	70	30	0	28	52	33	15	4
5	89	8	2	29	32	15	53	9
6	62	36	2	31	28	34	38	10
7	88	11	1	22	51	20	29	6
8	81	19	0	29	14	36	50	10
9	88	12	0	21	27	31	42	5
10	88	11	1	25	44	20	36	5
11	57	41	2	32	20	49	31	8
12	76	21	3	35	19	18	63	16
13	71	29	0	24	22	42	36	6
14	47	50	3	28	10	51	39	5
15	78	19	3	34	44	16	40	5
16	82	15	3	33	17	35	48	6
17	87	13	0	31	38	50	12	12
18	80	15	5	31	44	14	42	4
19	71	29	0	45	25	40	35	12
20	88	12	0	35	43	20	37	12
21	81	19	0	36	10	41	49	12
22	82	16	2	31	25	33	42	10
23	81	17	2	35	18	36	46	10
24	81	19	0	23	75	13	12	6
25	81	18	1	23	76	11	13	5
26	78	20	2	38	33	34	33	11
27	75	25	0	31	24	27	49	6
28	56	42	2	38	11	33	56	9
29	61	37	2	30	19	49	32	7
30	91	8	1	16	74	15	11	6
31†	-	-	-	-	34	44	22	9
Mean	77	22	1	30	33	31	36	8

* There was a typographical error in Question 2, period X, so the responses were not included in the analysis.

† Question 31 was added in period Y.

The questions in Part 1 may be categorized on the basis of their relationship to the inherent capability of AFCLAS and to the laboratory and administrative subsystems of the hospital system (Table VI-11); the questions in Part 2 may be categorized as directly or indirectly related to AFCLAS capabilities (Table VI-12). Based on the above categorization, more physicians responded positively than negatively in period Y to four of the seven questions directly related to AFCLAS capability; to none of 13 questions indirectly related to AFCLAS; to three of 10 questions related to the clinical laboratory; and to none of six related to administration (Table VI-13). In Part 2, more physicians responded positively than negatively in period Y to 11 of 17 questions directly related to AFCLAS capabilities and to one of 14 questions indirectly related to AFCLAS capabilities (Table VI-14).

The above indicates that the physicians tended to be more positive in period Y when the questions were directly related to the inherent capabilities of AFCLAS than when the questions were indirectly related to AFCLAS, related to the clinical laboratory, or related to the administrative system.

B. Registered Nurses

During March 1975, all registered nurses at MCWP, except operating room (OR) nurses, nurse practitioners, and nurse anesthetists, completed a forced choice questionnaire designed to measure acceptance of AFCLAS (Appendix E). During April 1976, 3 months after AFCLAS became functionally operational, substantially the same population completed a questionnaire that differed from the first questionnaire essentially only in the tense of the verbs.*

* There was a slight difference, however. In period Y civilian nurses were not included in the sample, whereas approximately 26 percent of the period X sample consisted of civilian nurses.

TABLE VI-11

CATEGORIZATION OF QUESTIONS ON PHYSICIAN'S QUESTIONNAIRE #1

Directly Related to AFCLAS Capability	Indirectly Related to AFCLAS Capability	Related to Clinical Laboratory	Related to Administration
Questions:	Questions:	Questions:	Questions:
1,19,20,21,24,26,30	4,5,6,8,10,12,13, 18,31,32,35,37	2,3,9,22,23, 25,29,33,34, 36	7,11,15,16, 17,27

TABLE VI-12

CATEGORIZATION OF QUESTIONS ON PHYSICIAN'S QUESTIONNAIRE #2

Directly Related to AFCLAS Capability	Indirectly Related to AFCLAS Capability
Questions:	Questions:
3,4,5,6,7,8,9,10,13,15, 17,18,20,21,24,25,30	1,2,11,12,14,16,19,22,23, 26,27,28,29,31

TABLE VI-13

POSITIVE RESPONSES IN PERIOD Y BY CATEGORY OF QUESTION - PHYSICIAN'S QUESTIONNAIRE #1

Positive Response to Questions Directly Related to AFCLAS Capability	Positive Response to Questions Indirectly Related to AFCLAS Capability	Positive Response to Questions Related to Clinical Laboratory	Positive Response to Questions Related to Administration
Questions:	Questions:	Questions:	Questions:
1,21,24,30	None	22,25,36	None

TABLE VI-14

POSITIVE RESPONSES IN PERIOD Y BY CATEGORY OF QUESTION - PHYSICIAN'S QUESTIONNAIRE #2

Positive Responses to Questions Directly Related to AFCLAS Capability	Positive Responses to Questions Indirectly Related to AFCLAS Capability
Questions:	Questions:
3,4,7,10,15,17,18 20,24,25,30	31

Ninety-seven percent of the nurses responded to the questionnaire before AFCLAS (period X) and 94 percent after AFCLAS (period Y). In computing the response rate, six nurses in period X were on Temporary Duty (TDY), leave, or had been reassigned and were not included; three nurses in period Y were on TDY or leave and were not included.

The mean standard score for responses to all the questions on the schedules was 50.03 for period X and 62.7 for period Y. This indicates that the acceptance by nurses was greater before AFCLAS than after AFCLAS. The mean standard score for every question was higher in period Y than in period X. The difference in each case was statistically significant at the 0.001 level.

The conclusions above speak for themselves. However, some insight may be obtained by considering the response data in detail. This does not affect the conclusions, of course. The statistical significance (probability of incorrectly concluding that there is a difference) of the difference between period X and period Y is based on a small sample size for those questions where the number of "no opinion" responses is high.

We assumed that the responses "strongly agree" and "agree" indicate favorable responses and "disagree" and "strongly disagree" indicate unfavorable responses. The responses were as follows:

	Period X	Period Y
Favorable	74%	31%
No change	24%	36%
Unfavorable	2%	33%

In period X most nurses had limited information on AFCLAS so an average of 32 percent of the responses to individual questions either were "no opinion" or were blank. In period X this percentage dropped to 18 percent. Table VI-15 presents the results by question.

C. Laboratory Staff

During March 1975 and again in April 1976, the laboratory staff completed questionnaires. The laboratory staff was defined as all people working in the laboratory except commissioned officers, secretaries, and volunteers. The questionnaire comprised two parts. The first part was a job satisfaction scale; the second part posed specific questions about clinical laboratory operation (Appendix E).

A total score on the job satisfaction scale was computed for each respondent. We obtained the mean score for period X and period Y and conducted a statistical significance test on the difference between means.

To score the job satisfaction questionnaire a numerical value of from 1 to 5 was assigned to the responses: from "strongly agree," which was assigned a value of 1, to "strongly disagree," which was assigned a value of 5.

The mean score in period X was 58.4 with a standard deviation of 8.3; the mean score in period Y was 55.2 with a standard deviation of 9.1. The difference is significant at the 0.10 level. Job satisfaction seemed to improve but the change was statistically significant at the level above that commonly used in practice, i.e., 0.05.

The second part of the laboratory staff questionnaire is reproduced as Laboratory Staff Questionnaire #2 after Table VI-15. The results of the analysis are presented

TABLE VI-15

REGISTERED NURSING QUESTIONNAIRE

PERIODS X AND Y

Question Number	Period X				Period Y			
	Percent Favorable	Percent No Change	Percent Unfavorable	Percent No Opinion or Blank	Percent Favorable	Percent No Change	Percent Unfavorable	Percent No Opinion or Blank
1	77	13	10	27	25	39	36	16
2	69	30	1	28	26	28	46	16
3	94	4	2	25	38	12	50	20
4	68	29	3	29	26	28	46	16
5	93	7	0	27	18	34	48	15
6	63	31	6	32	28	47	25	22
7	90	9	1	26	31	43	26	15
8	61	38	1	36	17	61	22	18
9	60	40	0	35	27	57	16	23
10	97	2	1	27	44	20	36	12
11	61	35	4	33	25	27	48	14
12	80	19	1	32	59	13	28	12
13	68	32	0	44	17	70	13	26
14	50	46	4	31	58	18	24	15
15	77	11	12	39	31	51	18	25
16	81	18	1	33	22	38	40	18
Mean	74	24	3	32	31	36	33	18

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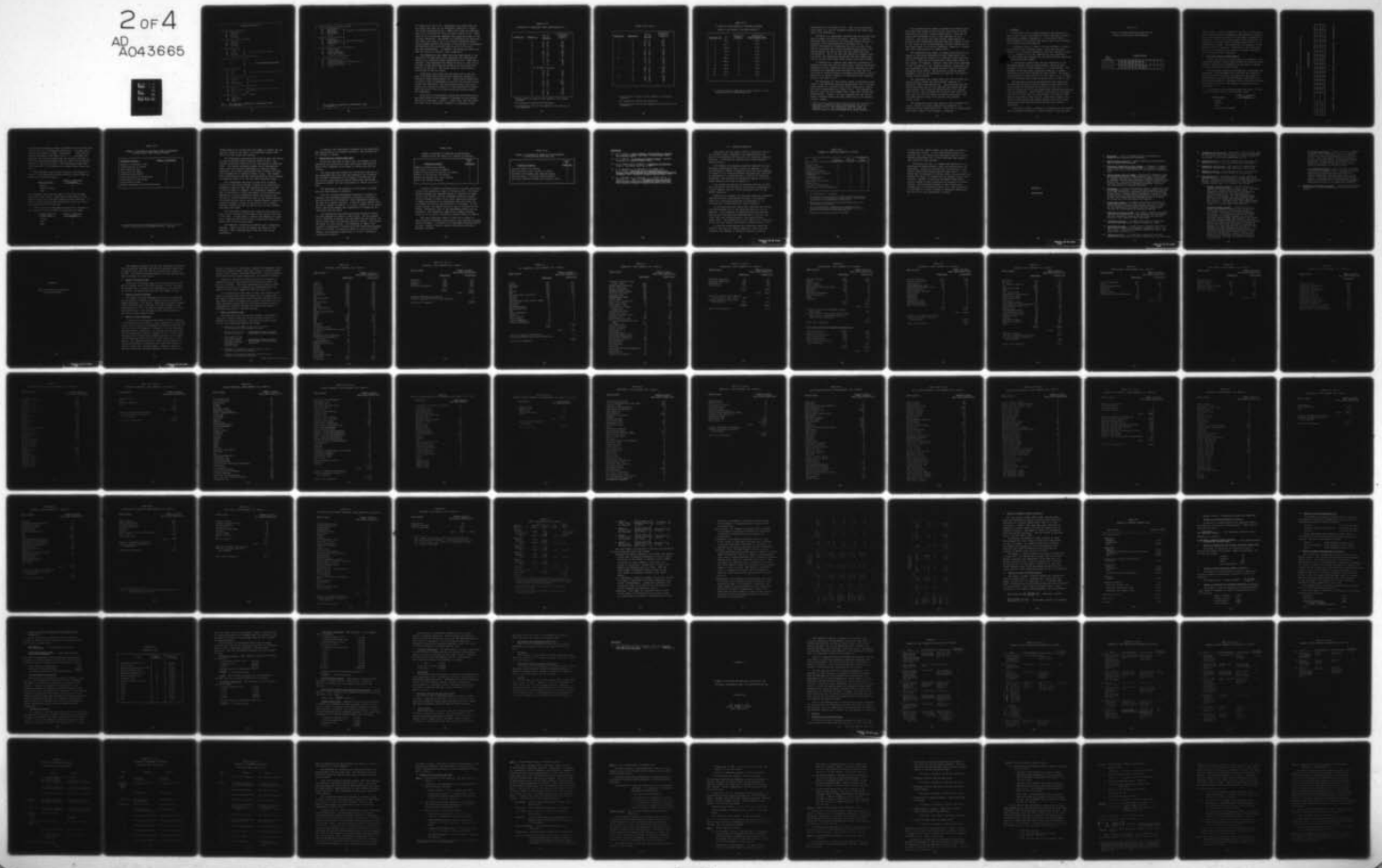

LABORATORY STAFF QUESTIONNAIRE #2

1. The normal work week in this laboratory is

1. ☐ less than 35 hours.
2. ☐ 35-40 hours.
3. ☐ 40-45 hours.
4. ☐ 45-50 hours.
5. ☐ over 50 hours.

2. During the past week, I worked in the laboratory

1. ☐ less than 35 hours.
2. ☐ 35-40 hours.
3. ☐ 40-45 hours.
4. ☐ 45-50 hours.
5. ☐ over 50 hours.

3. During the past week, I spent

1. ☐ 2 hours or less
2. ☐ 2-5 hours
3. ☐ 5-8 hours
4. ☐ 8-11 hours
5. ☐ over 12 hours

on military duties outside the laboratory.

* ☐ I have no military duties outside the laboratory.

4. During the past week, I was on pass or leave

☐ no
☐ 1
☐ 2
☐ 3
☐ 4
☐ 5

days. (not statistically analyzed)

5. During the past week, I worked

1. ☐ less than 1
2. ☐ 1-3
3. ☐ 3-6
4. ☐ 6-10
5. ☐ over 10

more hours than the normal work week in the laboratory.

6. In performing my tasks in the laboratory, I *feel that I have*

1. ☐ much more than
2. ☐ more than
3. ☐ all of
4. ☐ somewhat less than
5. ☐ much less than

the time that I need to accomplish my tasks.

7. In performing my tasks in the laboratory, I feel that I have

1. ☐ much more
2. ☐ more
3. ☐ about the same amount of
4. ☐ less
5. ☐ much less

time than (that) I would expect for a laboratory of this type.

8. When performing my tasks in the laboratory, I am rushed

1. ☐ rarely.
2. ☐ occasionally.
3. ☐ moderately often.
4. ☐ often.
5. ☐ very often.

ANSER
April W-P 1976

*Not included in computation of percentages listed in Table VI-16.

9. When performing my tasks in the laboratory, I am rushed

1. ☐ much less often than
2. ☐ less often than
3. ☐ about as often as
4. ☐ more often than
5. ☐ much more often than

* ☐ No opinion

} I would expect in a clinical laboratory of this kind.

10. The quality of reports in this laboratory is

1. ☐ far superior to
2. ☐ slightly superior to
3. ☐ about the same quality as
4. ☐ slightly inferior to
5. ☐ far inferior to

* ☐ No opinion

} reports for similar laboratories.

11. The time available for quality control in this laboratory is

1. ☐ more than is needed.
2. ☐ all that is needed.
3. ☐ almost all that is needed.
4. ☐ slightly less than is needed.
5. ☐ much less than is needed.

* ☐ Quality control is not part of my job.

12. In laboratories such as this, there is typically

1. ☐ more than enough time
2. ☐ all the time that is needed
3. ☐ almost as much time as is needed
4. ☐ less time than is needed
5. ☐ much less time than is needed

* ☐ No opinion

} for quality control.

*Not included in computation of percentages listed in Table VI-16.

in Tables VI-16 and VI-17. Respondents were asked what was the normal work week in the laboratory (Question 1, Laboratory Staff Questionnaire #2). There was a range of responses from "35 to 40 hours" to "over 50 hours" (Table VI-16). There seems to be no consensus regarding the normal work week in the clinical laboratory. The percent of respondents who perceived the normal work week to be 35 to 40 hours increased significantly between period X and period Y; the percent of respondents who perceived the normal work week to be 45 to 50 hours declined significantly. In general, the perceived normal work week was shorter in period Y than in period X.

The respondents were asked the hours they worked in the laboratory the week before they completed the questionnaire (Question 2, Laboratory Staff Questionnaire #2). There was a decline in the percentage who worked 40 hours or less, and an increase in the percentage who worked 40 or more hours from period X to period Y. The latter change is statistically significant at the 0.05 level.

Respondents were asked the time spent during the past week on military duties outside the laboratory (Question 3, Laboratory Staff Questionnaire #2). Thirty-three respondents in period X and 38 respondents in period Y had military duties outside the laboratory. The only statistically significant change was a decline in period Y in the percentage of respondents who spent 2 hours or less on military duties outside the laboratory.

There was no statistically significant difference before and after AFCLAS in any category of response to the question, "During the past week I worked ... more hours than the normal work week in the laboratory" (Question 5, Laboratory Staff

TABLE VI-16

RESPONSES TO LABORATORY STAFF QUESTIONNAIRE #2

Question No.	Response No.	Period X (Percent)*	Period Y (Percent)*	Statistical Significance Level †‡
1	1	0	0	NS
	2	10	25	0.05
	3	38	54	NS
	4	31	11	0.01
	5	21	10	NS
2	1	2	0	NS
	2	29	13	0.05
	3	39	44	NS
	4	17	23	NS
	5	12	20	NS
3	1	82	60	0.05
	2	9	26	NS
	3	3	3	NS
	4	0	3	NS
	5	6	8	NS
4	(Not included in analyses)			
5	1	41	24	NS
	2	27	32	NS
	3	10	15	NS
	4	10	20	NS
	5	12	8	NS
6	1	0	0	NS
	2	0	10	0.05
	3	42	13	0.01
	4	42	46	NS
	5	16	26	NS
7	1	4	0	NS
	2	6	3	NS
	3	39	26	NS
	4	35	26	NS
	5	18	44	0.05

* Percent refers to percent of total response in the category indicated.

† NS indicates not statistically significant.

‡ The significance tests for the responses to each question are not independent.

TABLE VI-16 (Cont.)

Question No.	Response No.	Period X (Percent)*	Period Y (Percent)*	Statistical Significance Level † ‡
8	1	11	2	NS
	2	21	29	0.05
	3	21	13	NS
	4	26	33	0.01
	5	21	29	NS
9	1	0	2	NS
	2	4	2	NS
	3	26	22	NS
	4	45	37	NS
	5	24	38	NS
10	1	11	11	NS
	2	26	11	NS
	3	54	51	NS
	4	4	15	NS
	5	4	13	NS
11	1	2	2	NS
	2	40	21	0.05
	3	18	17	NS
	4	27	21	NS
	5	13	38	0.01
12	1	0	0	NS
	2	43	28	NS
	3	23	24	NS
	4	27	24	NS
	5	7	23	NS

* Percent refers to percent of total response in the category indicated.

† NS indicates not statistically significant.

‡ The significance tests for the responses to each question are not independent.

TABLE VI-17

χ^2 TEST OF SIGNIFICANCE OF DIFFERENCE BETWEEN PERIOD X AND PERIOD Y FOR EACH QUESTION*

Question No.	χ^2	Degrees of Freedom	Statistical Significance Level
1	37.9	3	0.01
2	15.3	4	0.05
3	15.05	4	0.01
5	12.8	4	0.05
6	8.5	3	0.05
7	29.9	4	0.01
8	48.8	4	0.01
9	10.2	4	0.05
10	27.8	4	0.01
11	33.1	4	0.01
12	22.3	4	0.01

* A total score was computed for each question in the Laboratory Staff Questionnaire #2.

Questionnaire #2 and Table VI-16).* This is not surprising since there is a lack of consensus regarding the normal work week in the laboratory.

In period X no respondent indicated that he had more time than he needed to perform his tasks. However, 42 percent indicated that they had all the time they needed (Question 6, Laboratory Staff Questionnaire #2 and Table VI-16). In period Y the number of respondents who had more than enough time to accomplish their tasks increased significantly, but the percentage who had all the time they needed declined significantly. All of the data for Question 6 suggests that, in general, the respondents perceived that they needed less time to perform their tasks after AFCLAS than before AFCLAS.

In response to a question that asked the respondents to compare the time they had to perform their tasks at the Wright-Patterson clinical laboratory with similar laboratories, the percentage of respondents who perceived that they had much less time at Wright-Patterson increased significantly, from 18 percent to 44 percent (Question 7, Laboratory Staff Questionnaire #2 and Table VI-16).

The percentage who were rarely rushed in performing their tasks in the laboratory declined significantly from 11 percent before AFCLAS to 2 percent after AFCLAS (Question 8, Laboratory Staff Questionnaire #2, Table VI-16). The respondents perceive that they are somewhat more rushed after AFCLAS than before AFCLAS. However, the only response that was significantly different before and after AFCLAS was in the category "rarely" rushed.

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* Question 4, Laboratory Staff Questionnaire #2, was not analyzed since it was asked as an internal check on Question 2, i.e., if a respondent were on leave the previous week, he would be expected to check response 1.

The respondents were asked to compare the frequency with which they were rushed in the clinical laboratory at Wright-Patterson with similar clinical laboratories. There was no significant difference in any of the responses to this question. Both before and after AFCLAS, approximately 96 percent of the respondents perceived they were rushed as often or more often at the Wright-Patterson clinical laboratory as they would expect in a similar laboratory (Question 9, Laboratory Staff Questionnaire #2, Table VI-16).

The respondents were asked to compare the quality of the reports at the Wright-Patterson clinical laboratories with similar laboratories (Question 10, Laboratory Staff Questionnaire #2). There was no statistically significant change in any category of response. However, there were fewer responses in the "far superior" and "slightly superior" categories, and more responses in the "slightly inferior" and "far inferior" categories after AFCLAS. The direction of change appears, therefore, to be in the direction of "inferior" from before AFCLAS to after AFCLAS.

The respondents were asked about the time available for quality control before and after AFCLAS (Question 11, Laboratory Staff Questionnaire #2). The percentage who perceived that there was all the time that was needed declined significantly from 40 percent before AFCLAS to 21 percent after AFCLAS. The percentage who perceived that there was much less time than was needed increased significantly from 13 percent before AFCLAS to 38 percent after AFCLAS (Table VI-16).

The respondents were asked about the time available for quality control in typical laboratories (Question 12, Laboratory Staff Questionnaire #2). There was no statistically significant change in any category of response.

D. Patients

During March 1975, a random sample of 182 patients who came to the clinical laboratory for tests completed a patient satisfaction schedule (Appendix E). During April 1976, a random sample of 211 patients who came to the clinical laboratory completed the same schedule.

A numerical value of from 1 to 5 was assigned, in order, for responses from "strongly agree," which was assigned a value of 1, to "strongly disagree," which was assigned a value of 5. A composite score was computed for each respondent and a mean score was computed for the before-AFCLAS sample and for the after-AFCLAS sample.

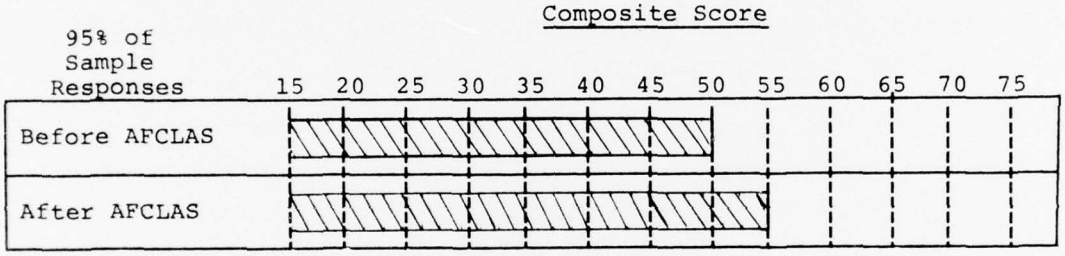
A statistical significance test was conducted on the difference between the two sample means. The mean score increased from 33.7 before AFCLAS to 37.7 after AFCLAS. The increase in the mean score indicated a decline in patient satisfaction from before AFCLAS to after AFCLAS. The change is statistically significant at the 0.01 level (i.e., a change of this magnitude would occur by chance only one time in 100).

Patients were generally satisfied with the laboratory. The 95th percentiles of patient composite scores before and after AFCLAS are presented in bar form in Figure VI-1. A score of higher than 45 on the scale would indicate satisfaction with the laboratory. Before AFCLAS, 95 percent of the sample had scores of less than 50; after AFCLAS, 95 percent of the sample had scores of less than 55. There were slightly more above 45 after AFCLAS than before AFCLAS, but in both cases the patients were generally satisfied with the clinical laboratory.

The largest change in response to questions on the schedule was in response to Question 2, which relates to waiting time

FIGURE VI-1

RANGE OF PATIENT COMPOSITE SCORES ON THE PATIENT SATISFACTION QUESTIONNAIRE



(Table VI-18). AFCLAS introduced a new form for laboratory test requests and new procedures in the laboratory reception area, which possibly accounts for the change in response to Question 2. The average waiting time in the laboratory for the patient increased from 19 minutes before AFCLAS, to 32 minutes after AFCLAS. The reasons for the changes in other responses are not apparent. Innovation in the laboratory might be an explanation, or waiting time might influence the responses to other questions.

E. Outpatient Medical Records Staff

During the last week in March 1976, all members of the outpatient medical records staff present for duty were interviewed to obtain their perception of the impact of AFCLAS upon the outpatient records section.

The interview technique was essentially controlled non-directive. The respondents were told that the purpose of the interview was to obtain information on the impact of AFCLAS upon the patient records section, especially as it affected the amount of time spent filing, the ease of filing, the volume to be filed, and adoption of improved filing techniques.

The response to the question about the amount of time spent filing are shown in the following table.

Time to File	Number of Responses in Category
Longer	6
Shorter	1
Same	3
No definite response	1

TABLE VI-18

ARITHMETIC MEAN OF RESPONSES TO PATIENT SATISFACTION QUESTIONNAIRE

Question Number*

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Before AFCLAS	2.1	2.6	2.2	2.1	2.1	2.1	2.2	2.3	2.2	2.2	2.0	2.2	2.3	2.4	2.6
After AFCLAS	2.3	3.2	2.5	2.3	2.4	2.4	2.5	2.5	2.4	2.6	2.2	2.4	2.6	2.5	2.8

* Numbers refer to question numbers on patient satisfaction schedule. See Appendix E.

The perceived increase in time is probably due to the fact that reports are now in alphabetical order by patient name, while files are in numerical order. The problem was mentioned by several respondents (see Table VI-19). The respondent who said that the time was shorter was not directly involved in filing of records and thought that the time would be shorter because of cumulative reports. The respondent stated that there were now "...10 pieces to file where before there were 30...."

The respondents were evenly divided on the question of whether filing was easier or more difficult after AFCLAS as shown in the following table.

Ease of Filing	Number of Responses in Category
Easier	5
More Difficult	5
Same	1

One respondent said that the ease of filing was the same before and after AFCLAS. There was no consistency in the reasons given for filing being easier or more difficult. In fact, in some cases the same reasons were given for filing being easier and more difficult.

A majority of the respondents perceived an increase in the volume of reports as shown in the following table.

Volume of Records To Be Filed	Number of Responses in Category
Greater	7
Less	0
Same	4

TABLE VI-19

NUMBER OF RESPONSES TO QUESTION, "WHAT IMPROVEMENTS IN AFCLAS WOULD HELP PATIENT RECORDS?"

Response Category	Number of Responses
Reports in numerical order	5
Identification of patient	4
More tests per page	2
Break down the sheets	2
Interface with MAMS-R*	2
Less duplication of information	1
Construction of the record	1
Slips keyed to base	1
Reduce frequency of cumulative reports	1

* Medical Administrative Management System - Revised.

Volume appeared to include both the number of reports and the physical volume of the forms. No respondent thought that there was less volume after AFCLAS.

The respondents were asked what could be done with AFCLAS to help the patient records section (Table VI-19). The response cited most often was to put the reports in numerical order. The AFCLAS laboratory reports are in alphabetical order while the files are maintained in numerical order. Therefore, the patient records staff has to change the order from alphabetical to numerical before filing. Four respondents estimated the time that would be saved by having reports in numerical order at 50, 48, 25, and 16 hours per week.

Four respondents said that it would help to better identify on the reports whether a report is an inpatient or outpatient report so that the records staff would not have to refer to names or numbers. One respondent suggested that it would help if slips were keyed to the military base. Apparently, clinical laboratory reports for patients not assigned to Wright-Patterson are sent to the records section. The records section has no way of knowing whether a report on a patient without a record in the files is for a Wright-Patterson patient who does not have a file or for a patient from some other base.

Two respondents suggested that there be more tests per page; this is related to the volume of the reports that have to be filed. In some cases, a single line appears on a page and it takes as much time to file a single-line report as a report that fills an entire page.

The response "interface with MAMS-R" was a categorical response. There is no way of knowing the basis for the response. Other responses were cited only once by the respondents.

In general, the improvements suggested by the respondents have administrative or software solutions. The problems are not inherent in AFCLAS.

F. Admissions and Dispositions Staff

During the last week in March 1976, all members of the Admissions and Dispositions (A&D) staff were interviewed to obtain their response to the impact of AFCLAS upon the A&D section.

The interviews were essentially controlled nondirective. The respondents were told that the purpose of the interview was to obtain information on the impact of AFCLAS upon the A&D section, especially how AFCLAS affects A&D; how AFCLAS relates to MAMS-R; and what improvements in AFCLAS would help A&D.

The responses to the questions on the effect of AFCLAS upon A&D were related to workload.

Five out of eight respondents perceived an increase in workload, one respondent perceived a decrease in workload, and two perceived no difference. Most respondents perceived the same or a greater workload. It was not clear whether this was due to AFCLAS, to MAMS-R, or to both. MAMS-R was introduced during the period between the installation of AFCLAS and the interviews with A&D staff.

The respondents were asked how AFCLAS related to MAMS-R and the responses are shown in Table VI-20. The two systems do not interface at present, but the MAMS-R CRT and printer are used to print admit and transfer cards for AFCLAS. The printer was added for this purpose. The responses in Table VI-20 indicate a difference of opinion as to the relationship between MAMS-R and AFCLAS. As indicated, MAMS-R is used with AFCLAS. However, the responses suggest that it is not a completely satisfactory relation.

TABLE VI-20

NUMBER OF RESPONSES TO QUESTION ON RELATIONSHIP BETWEEN AFCLAS AND MAMS-R, BY CATEGORY OF RESPONSE

Response Category	Number of Responses
MAMS-R interfaces with AFCLAS	5
A&D slower with AFCLAS and MAMS-R	3
MAMS-R complicated introduction of AFCLAS	1
MAMS-R is the problem, not AFCLAS	1
MAMS-R and AFCLAS don't work together	1
MAMS-R and AFCLAS unrelated	1

Interface of MAMS-R and AFCLAS was the response most often cited to the question of impact of AFCLAS on A&D. The inconsistency between the response related to interface in Table VI-20, which implies that the interface exists at present, and the response in Table VI-21, which identifies interface of MAMS-R and AFCLAS as an improvement that would help A&D, is probably related to the definition of interface. In the present system, the MAMS-R system is used in conjunction with AFCLAS. Apparently, some of the respondents define this as interface. The response in Table VI-21 probably defines interface as an online relationship between AFCLAS and MAMS-R.

The other responses listed in Table VI-21 relate to administrative procedures rather than to the inherent characteristics of AFCLAS. In general, the respondents accepted AFCLAS but see a number of ways to improve the system with major changes in AFCLAS.

TABLE VI-21

NUMBER OF RESPONSES TO QUESTION ON IMPROVEMENTS TO AFCLAS THAT WOULD HELP A&D

Response Category	Number of Responses
Interface MAMS-R and AFCLAS	4
Send laboratory slips directly to wards	3
Use data field rather than required format	2
Identification of inpatient and outpatient	1
Use Social Security number with register number	1

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VII. NONDOLLAR BENEFITS

Physicians are the primary users of laboratory reports and therefore their responses to the questionnaires and during the interviews form the basis for assessing nondollar benefits. In addition we studied some of these benefits quantitatively.

The analysis for assessing nondollar benefits from the physician questionnaire data is given in Appendix D. From the analyses and tables of interview data that were presented in Chapter VI, we extracted whether the physicians perceived an improvement or a deterioration in each of the nondollar categories. The quantitative studies of several of the nondollar benefits are given in Chapter II.

Even though the analysis of nondollar benefits is somewhat qualitative and the results can be easily summarized in a brief chapter, they are a very significant part of the AFCLAS evaluation.

Physicians in general felt that the nondollar categories improved with the installation of AFCLAS. As given in Table VII-1 physicians perceived an improvement in 13 instances and a deterioration in seven instances.

On the questionnaires, physicians responded that patient care deteriorated, but in the interview they felt that it improved. The difference in perception may have resulted because the interviews were conducted about 2 months later (June 1976) than administration of the questionnaires (April 1976). The ambiguity may also indicate that physicians do not feel that AFCLAS significantly affected patient care.

In both the questionnaires and interviews physicians reported that they felt AFCLAS improved or that there was a benefit with respect to cumulative reports, retrieval

TABLE VII-1

SUMMARY OF NONDOLLAR BENEFITS OF AFCLAS

Item	Physician Questionnaires	Physician Interview	Quantitative Data Available
Patient Care	D*	I	---
Cumulative Reports	I	I	---
Lost Reports †	D	I	Yes
Legibility of Reports	I	I	---
Turnaround Time for Routine Reports ‡	D	I	Yes
Turnaround Time for *Stat* Reports §	D	D	Yes
Retrieval of Test Results	I	I	---
Report Format	I	I	---
Accuracy of Test Results ‖	D	D	---
Provides More Patient Information	I	I	---

* D = deteriorated, I = improved.

† The percentage of reports filed in OMR increased significantly (0.05 level). The percentage of reports filed in IMR decreased slightly but was not statistically significant.

‡ Routine report turnaround time increased significantly in all departments except Serology.

§ Of six determinations, turnaround time increased for all. The ratio of times was statistically significant at the 0.001 level for five, and at the 0.05 level for one.

‖ Accuracy is not directly affected by AFCLAS.

of test results, report format, and the amount of patient information provided. On the questionnaires physicians reported that lost reports and turnaround time for routine reports deteriorated, but in the interviews they reported that these two items improved.

Turnaround time for *stat* reports was perceived by the physicians as deteriorating in both the questionnaires and interviews. Physicians reported that the accuracy of test results deteriorated between period X and period Y. Since AFCLAS was not designed to directly affect the way technicians perform the tests, it probably did not directly affect test accuracy. However, it may have decreased transcription errors, thereby actually improving the accuracy of reported results. The perceived decrease in test accuracy was probably due to intervening factors (e.g., the installation of the HYCEL-17 or other changes in laboratory operations) and not due to the installation of AFCLAS.

APPENDIX A

DEFINITIONS

1. Acceptance - level of system approval as measured by scores on an acceptability instrument.

2. Administrative reports - reports required by Headquarters USAF or subordinate commands.

3. Cumulative summaries or flow sheets - a summary of laboratory test results displayed so that it is easy to observe trends over time in the results of any specific laboratory test.

4. Direct dollar cost of AFCLAS - consists of operating costs and acquisition costs. The operating costs include rental of computer hardware and auxiliary equipment, maintenance of computer and auxiliary equipment, computer supplies, and electricity. The acquisition costs include facility modification, acquisition of permanent equipment, shipping, and installation of computer hardware.

5. Hypothesis - a tentative assumption about a potential impact of introducing AFCLAS. Use of the term hypothesis does not imply that statistical hypothesis testing will be applied in each case. However, where appropriate, validity of the hypothesis will be tested using standard statistical techniques. The hypotheses are intended primarily to serve as a guide for data collection and analysis.

6. Intervening factor - a change in operation or policy of either the laboratory or the hospital that occurs between the beginning of period X and the end of period Y, that was not associated with AFCLAS, and that could affect the data to be collected for evaluating AFCLAS.

7. Laboratory clinical forms - all forms (including log books) used in the laboratory for test requests, test processing, and test reporting; quality control forms and internal records of the number of tests performed.

8. Laboratory reports - all paper forms sent to physicians to report the results of clinical laboratory tests.

9. Laboratory request - a paper form or computer card sent to the clinical laboratory to request laboratory tests. In some cases, a request may become a laboratory report when results are written on it.

10. Laboratory staff - all laboratory personnel, excluding pathologists, laboratory officers, secretaries, and volunteers.

11. Quality of patient care - the degree to which health care provided by a health care system or a specified component of that system meets the standards or norms implicit in the system or explicitly established for it.

12. Job satisfaction - level of overall job contentment as measured by scores on a job satisfaction instrument.

13. Laboratory technicians - used herein to include both laboratory technologists and laboratory technicians.

14. Telephone inquiry - any telephone call to the clinical laboratory to obtain test status or test results.

15. Turnaround time - time from arrival of the request in the laboratory to time the report is ready for distribution. The specific definition of turnaround time varied slightly between period X and period Y, and between a routine request and a *stat* request, as follows:

    Routine request period X - time of arrival of request is actual time of arrival for all requests that arrive between 0600 and 2000 hours. A constructive time of 0600 hours is assigned to routine requests that arrive between 2000 hours and 0600 hours. (At MCWP, requests were actually time stamped into the laboratory about 0700 hours and blood was collected on morning draw rounds.) Completion time occurs when reports are brought to the front desk, time stamped, and placed in a box for later distribution.

    Routine request period Y - time of arrival is actual time the test request card is read into the AFCLAS system in the reception area for all request cards that arrive between 0600 and 2000 hours. A constructive time of 0600 hours is assigned to routine requests that are read into the system between 2000 hours and 0600 hours. (At MCWP, request cards were actually read into the AFCLAS system just prior to morning draw rounds between 0615 hours and 0645 hours.) Completion time is the time daily cumulative summaries are printed. At MCWP, reports were actually printed between 0300 and 0400 hours in the morning following the day the tests were validated, but the online computer clock was set back to 2200 hours the previous day. Hence, a constructive print time of 0400 hours is assigned, which is 1 calendar day following the date that appears on the report.

Stat request period X - time of arrival of request is actual time of arrival for all *stat* requests. Completion time occurs when reports are brought to the front desk, time stamped, and placed in a box for later distribution. Note that the turnaround time defined herein is turnaround time for paperwork. In most cases, the results of *stat* tests are telephoned to the physician prior to bringing the report to the front desk.

Stat request period Y - time of arrival is actual time the test request card is read into the AFCLAS system in the reception area. Completion time occurs when reports are printed on the *stat* printer immediately following validation of the results. Note that the turnaround time defined herein is turnaround time for paperwork. In most cases, the results of *stat* tests are telephoned to the physician prior to validation and printing.

16. Usability of laboratory reports - qualitative assessment by physicians of the convenience and practicability of reports.

APPENDIX B

DATA AND ANALYSIS FOR DERIVING WORKLOAD CONSTANTS

This appendix presents the raw data and shows the derivation of workload constants used with the activity (task) time to compute total task time for the 31 tasks time studied by the MET. The workload constants derived in this appendix were used in Chapter III, Table III-2.

A. Number of Calendar Days

There were 90 calendar days in the first quarter of 1975 and 91 calendar days in the first quarter of 1976. We used 90 calendar days as a basis for calculations in the analysis so that the two periods would be the same length of time.

B. Number of Normal Workdays

The number of normal workdays in the period was defined as the number of weekdays in the period minus the number of Federal holidays in the period. There were 62 normal workdays in the first quarter of 1975 and 63 normal workdays in the first quarter of 1976. We used 62 normal workdays as a basis for calculations in the analysis so that the two periods would be the same length of time.

C. Number of Tests Requested

As derived in this section the number of tests requested is an estimate of the number of tests ordered by the physicians rather than the number of procedures performed as reported on Air Force Form 235d (Report of Patients - Clinical Laboratory Quarterly Report Supplement). We obtained the raw data from the Noncommissioned Officer in Charge (NCOIC) of the clinical laboratory who has maintained complete records of the number of procedures performed per day for each test over a 3-year period. The numbers reported are lower than the number of procedures performed as reported on AF Form 235d because we did not include the following items: standards, controls, specimen collection, specimen handling, tests routinely per-

formed in duplicate or triplicate, hospital environmental survey, Center for Disease Control (CDC) and College of American Pathologists (CAP) surveys, plate/tube subcultures, tube biochemicals, plate sensitivities, media preparation, and specimens shipped.

Tables B-1 through B-9 report the period X workload, by laboratory section, and Tables B-10 through B-20 report the period Y workload. Table B-21 summarizes the number of tests requested by section, by inpatient and outpatient tests for period X, and by total number of tests for period Y.

It is important to note that in using this workload information to compute task times in Chapter III, we always used the period Y workload because task times were defined to be the net change between the benefits and costs of operating the clinical laboratory during period Y with AFCLAS support and the (hypothetical) benefits and costs of handling the period Y workload using period X (manual) methods.

D. Number of Request Slips

The workload factor is the total number of the period X three-part request slips that would have been required to process the period Y workload. The computation was carried out for each laboratory section as follows:

1. Estimate the total number of slips used in period X (to be described for each laboratory section).

2. Average number of tests per slip in period X $= \frac{\text{total number of tests in period X}}{\text{total number of slips in period X}}$.

3. Total number of slips that would have been required to process the period Y workload (referred to as period Y slips) $= \frac{\text{total number of tests in period Y}}{\text{average number of tests per slip in period X}}$.

4. Determine the percentage of period X slips that are for inpatients (use period X statistics).

5. Determine the percentage of period X slips that are for outpatients (use period X statistics).

(Text continued on page 150.)

TABLE B-1

CHEMISTRY, FIRST QUARTER 1975, PERIOD X

Name of Test	Number of Tests Jan., Feb., March 1975	
	Inpatients	Outpatients
Lipase	37	18
Glucose	2161	4403
Calcium	1658	1456
Uric Acid	1534	1973
Protein	1634	1190
Bilirubin	2346	1792
Cholesterol	1331	1613
CO_2	1738	987
Urine Specimen	217	324
BUN	2827	2506
Triglycerides	1177	1502
Sodium	1598	1439
Amylase	173	183
Acid Phosphatase	31	145
BSP	3	5
Spinal Fluid Protein	8	1
Xylose	29	4
SGOT	1530	2067
SGPT	1024	913
LDH	1456	1313
CPK	1211	247
Aldolase	8	8
Lithium	103	18
Serum Iron, TIBC	200	77
17-Keto and 17-Hydroxy Steroids	60	47
Cortisols	59	19
Estriol	33	94
Hemoglobin Electrophoresis	66	29
Protein Electrophoresis (5 bands)	82	51
Immunodiffusion	107	28
Alpha-1-Antitrypsin	0	1
Alcohol	9	1
G6-PDH	0	0
Ammonia	4	1
Magnesium	135	11
Salicylates	2	1
Barbiturate Level	0	0
Creatinine	2393	2160
Phosphorus	1390	1263

TABLE B-1 (cont.)

CHEMISTRY, FIRST QUARTER 1975, PERIOD X

Name of Test	Number of Tests Jan., Feb., March 1975	
	Inpatients	Outpatients
Chloride	1442	837
Potassium	1358	1243
Albumin	1356	1024
Alkaline Phosphatase	1986	1544
	34516	32538
	Total	67054
Subtract Standards and Controls		0
Subtract Specimen Collection and Handling		0
Total Tests Requested		67054

TABLE B-2

STAT LABORATORY, FIRST QUARTER 1975, PERIOD X

Name of Test	Number of Tests Jan., Feb., March 1975	
	Inpatients	Outpatients
Sodium	820	125
Potassium	819	125
Chloride	820	125
CO2	819	125
Glucose	878	215
BUN	634	136
Bilirubin-Total and Direct	422	38
Amylase	89	38
Calcium	47	6
Cerebrospinal Fluid Protein (CSF)	72	11
Salicylate	1	4
Acetone	82	3
Acid Phosphatase	1	1
Barbiturate Level	0	0
BSP	0	0
Fetal Hemoglobin	0	0
Albumin	0	0
Total Protein	12	1
Sweat Sodium	3	3
Gastric Analysis	10	0
Gastric Collections	10	0
	5539	956
	Total	6495
Subtract Standards and Controls		0
Subtract Specimen Collection and Handling		0
Total Tests Requested		6495

TABLE B-3

HEMATOLOGY, FIRST QUARTER 1975, PERIOD X

Name of Test	Number of Tests Jan., Feb., March 1975	
	Inpatients	Outpatients
Automated Complete Blood Count (CBC)	3108	5646
Morphology-Differential	2920	5476
Manual Hematocrit	541	917
Manual Hemoglobin	540	917
Platelet Count, Slide	461	636
Reticulocyte Count	295	479
Platelet Count	109	155
Sedimentation Rate	527	1358
Manual RWBC	390	786
Body Fluid Differential	34	27
Body Fluid Count	61	25
Nasal Smear / EOS	17	141
Red Blood Count (RBC) Morphology	7	-
Differential (Only)	4	4
Sickle Cell Test	27	98
Lee-White Clotting Time	27	44
Bleeding Time	80	104
Prothrombin Time (PT)	1077	995
Partial Thromboplastin Time (PTT)	1213	608
Clot Retraction	2	3
Factor VIII Assay	4	6
Factor IX Assay	1	-
Fibrinogen	54	44
Tourniquet Test	4	2
Total Eosinophil Count	9	20
Bone Marrow Preparation	21	16
Anti-Nuclear Antibody	168	420
LE Preparation	10	8
Malaria Smear	1	8
RBC Fragility	18	9
Hams Test	3	5
Leukocyte Alkaline Phosphatase	26	26
Buffy Coat	3	2
Giemsa Stain	78	124
Basophilic Stippling	125	164

TABLE B-3 (cont.)

HEMATOLOGY, FIRST QUARTER 1975, PERIOD X

Name of Test	Number of Tests Jan., Feb., March 1975	
	Inpatients	Outpatients
Automated Hematocrit	388	260
Automated Hemoglobin	371	244
Venipuncture	4425	7571
Finger Stick	415	884
	17564	28232
	Total	45796
Subtract Standards and Controls (10 percent of (PT + PTT))	229	160
Subtract Specimen Collection and Handling	4840	8455
	12995	19617
Total Tests Requested		32112

TABLE B-4

BACTERIOLOGY, FIRST QUARTER 1975, PERIOD X

Name of Test	Number of Tests Jan., Feb., March 1975	
	Inpatients	Outpatients
Routine Cultures	4830	14065
Smears	2340	1390
Direct Smears	0	55
Blood Cultures	684	0
AFB Cultures and Subcultures	791	51
AFB Smears	286	29
Mycology	447	36
Darkfield Microscopy	0	21
Special Shipping	0	0
Semen	1	41
Vasectomy	0	46
	9379	15734
	Total	25113
Subtract Hospital Environmental Survey (Estimate)		1200
Subtract Center for Disease Control (CDC) and College of American Pathologists (CAP) Surveys (Estimate)		150
Total Tests Requested		23763
Other Items Routinely Counted by Bacteriology		
Specimen Handling	25224	70644
Patient Collection	4830	14065
Plate/Tube Subcultures	1899	664
Tube Biochemicals	5064	8436
Plate Sensitivities	690	560
Bottle Blood Subcultures	1690	0
Plate/Tube Media	0	41124
	37707	137183
	Total	174890

TABLE B-5

URINALYSIS, FIRST QUARTER 1975, PERIOD X

Name of Test	Number of Tests Jan., Feb., March 1975	
	Inpatients	Outpatients
Routine Urinalysis	3621	6562
Specimens Collected	3621	6562
Urobilinogen	17	10
Urine Measured, 24 hr	371	430
Quantitative Protein, 24 hr	57	47
Porphobilinogen	20	2
Nitroprusside (Actone)	0	0
Addis Count	0	0
Porphyrins	4	0
Melanogen	0	0
Hemosiderin	3	0
Hemogenistic Acid	0	0
Specimens Shipped	45	65
Bence Jones Protein	6	0
	7765	13678
	Total	21443
Subtract Standards and Controls		0
Subtract Specimen Collection and Handling		10183
Total Tests Requested		11260

TABLE B-6

SEROLOGY, FIRST QUARTER 1975, PERIOD X

Name of Test	Number of Tests Jan., Feb., March 1975	
	Inpatients	Outpatients
ASO Titer	170	191
RA Titer	293	483
C - Reactive Protein	91	133
RPR	1286	2248
Quantitative RPR	262	101
FTA	66	109
Mono Test, Slide	284	401
Heterophile, Differential	77	119
Guinea Pig Kidney	74	109
Beef Erythrocytes	97	101
Thyroid A	48	58
Cold Agglutination	61	94
Streptococcus MG Agglutination	27	41
UCG Pregnancy Test, 2 hr	273	563
Pregnostrom	95	137
Histoplasmosis Test	49	70
Coccidiomycosis Test	49	70
Febrile Agglutination	51	53
Colloidal Gold	18	24
Rubella	143	409
Specimens Shipped	218	297
Specimens Collected	180	248
VDRL	197	218
	2750	4700
	Total	7450
Specimens Shipped		515
Subtract Standards and Controls		2000
Subtract Specimen Collection and Handling		428
Total Tests Required		7450

TABLE B-7

PARASITOLOGY, FIRST QUARTER 1975, PERIOD X

Name of Test	Number of Tests Jan., Feb., March 1975	
	Inpatients	Outpatients
Ova and Parasites	137	132
Guiac	473	216
Pinworm Preparation	0	45
Fat Stain	12	8
Urobilin	0	0
Special Tests	9	0
Gross Blood and Inconsistency	26	25
	657	426
	Total	1083

TABLE B-8

BLOOD BANK, FIRST QUARTER 1975, PERIOD X

Name of Test	Number of Tests Jan., Feb., March 1975	
	Inpatients	Outpatients
ABO Hemolysin	-	0
Indirect Coombs	163	360
Direct Coombs	280	30
Antibody Identification	29	38
Antibody Titer	-	-
Rhogam Crossmatch	33	-
	505	428
	Total	933

TABLE B-9

BUILDING 40, FIRST QUARTER 1975, PERIOD X

Name of Test	Number of Tests Jan., Feb., March 1975
	Outpatients
Serology (RPR)	2000
Hematology (Hematocrit)	1824
Urinalysis (Routine)	1165
Urinalysis (Microscopic)	1825
Chemistry (Glucose)	932
Hematology (CBC)	143
Chemistry (2 hr PP)	177
Bacteriology (G.C.)	5
Blood Bank (Bt and Rh)	356
Hematology (Sickle Dex.)	295
Chemistry (Shipped)	1211
Urinalysis Total (Collected)	2990
Serology Total (Venipuncture)	3295
Bacteriology (Total Collected)	295

TABLE B-10

AUTOMATED CHEMISTRY, FIRST QUARTER 1976, PERIOD Y

Name of Test	Number of Tests Jan., Feb., March 1976
Glucose, Fast	241
Glucose, 30 Min	225
Glucose, 1 hr	224
Glucose, 2 hr	1178
Glucose, 3 hr	224
Glucose, 4 hr	160
Glucose, 5 hr	142
Glucose, 6 hr	3
BUN-17	682
Creatinine-17	735
LDH-17	549
Phosphorus-17	268
Calcium-17	401
SGPT-17	563
SGOT-17	746
Alkaline Phosphatase-17	393
Cholesterol-17	578
Uric Acid-17	441
Total Protein-17	238
Albumin-17	200
Glucose-17	1068
Bilirubin Total-17	434
IV Tol, Fasting	2
IV Tol, 10 min	1
IV Tol, 20 min	1
IV Tol, 30 min	1
HYCEL-17	83833
Triglyceride-17	496
CPK-17	318
Globulin-12	7
G/A Ratio	88
Lactose, Fast	1
Lactose, 30 min	1
Lactose, 1 hr	1
Lactose, 2 hr	1
Lactose, 3 hr	1
Lactose, 4 hr	1
Lactose, 5 hr	1

TABLE B-10 (cont.)

AUTOMATED CHEMISTRY, FIRST QUARTER 1976, PERIOD Y

Name of Test		Number of Tests Jan., Feb., March 1976
LDH, Body Fluid		7
TIBC		144
Aldolase (ABA-100)		1
Iron		107
	Total	94706
Subtract Standards and Controls		0
Subtract Specimen Collection and Handling		0
Total Tests Requested		94706

TABLE B-11

MANUAL CHEMISTRY, FIRST QUARTER 1976, PERIOD Y

Name of Test	Number of Tests Jan., Feb., March 1976
Serum Osmolality	20
Urine Osmolality	18
Calculation	8
G6-PDH	24
Alcohol	12
Creatine, Urine	1
Hemoglobin, Plasma	5
Radial, Immunodiffusion	23
Serum Iron	86
Serum TIBC	85
Type/LPE	114
Ammonia	2
Haptoglobin	27
Alpha-I-Antitrypsin	7
Acid Phosphatase	90
Cortisol	137
Sodium, Sweat	24
Change OD	19
L/S Ratio	2
Protein	170
Albumin	168
Alpha 1	168
Alpha 2	168
Beta	168
Gamma	166
Estriol	266
Total Vol./ml.-Estriol	266
E/C Ratio	267
BSP	4
HGB Electrophoresis	100
Creatinine, mg.	297
Creatinine, gms.	279
Serum Creatinine	37
Total Vol./ml.-Creatinine Clearance	36
Creatinine	36
Ml. per min	36
17-Hydroxy Steroids	106
Total Vol./ml.-17-Hydroxy	109
17-Keto Steroids	110
Total Vol./ml.-Creatinine	280
Total Vol./ml.-17-Keto Steroids	110
Phosphorus, mg.	42

TABLE B-11 (cont.)

MANUAL CHEMISTRY, FIRST QUARTER 1976, PERIOD Y

Name of Test	Number of Tests Jan., Feb., March 1976
Total Vol./ml.-Phosphorus	32
Phosphorus, gms.	31
Uric Acid, mg.	45
Total Vol./ml.-Uric Acid	43
Uric Acid, gms.	43
Calcium, mg.	74
Total Vol./ml.-Calcium	63
Calcium, gms.	48
Glucose, mg.	13
Total Vol./ml.-Glucose	13
Glucose, gms. in 24 hr	11
Creatinine, Estriol	265
Creatinine, 17-Hydroxy	108
Creatinine, 17-Keto Steroids	110
Total Vol./ml.-Xylose	1
Gms. Xylose Excreted	1
Albumin, Urine Electrophoresis	2
Alpha 1, Urine Electrophoresis	2
Alpha 2, Urine Electrophoresis	2
Beta, Urine Electrophoresis	2
Gamma, Urine Electrophoresis	2
A/G Ratio, Serum Electrophoresis	170
Cryoglobulins	17
Comp B1A	23
Comp B1C	27
Comp B3C	42
Osmolality Cerebrospinal Fluid (CSF)	1
Creatinine (Ammio F)	17
Triglyceride (LPE)	135
Cholesterol (LPE)	133
CSF Glucose	31
Glucose, Synovial Fluid	1
Magnesium	8
Lithium	35
Total	5644
Subtract Standards and Controls	0
Subtract Specimen Collection and Handling	0
Total Tests Requested	5644

TABLE B-12

IMMEDIATE RESPONSE LABORATORY, (*STAT* LABORATORY), FIRST QUARTER 1976, PERIOD Y

Name of Test	Number of Tests Jan., Feb., March 1976
Cerebrospinal Fluid (CSF) Total Protein	110
CSF Glucose	72
Protein, Body Fluid	9
Glucose, Body Fluid	5
Mucin, Body Fluid	-
Uric Acid, Body Fluid	1
Specific Gravity, Body Fluid	1
Calcium, Urine	2
Bilirubin, Direct	179
Bilirubin, Direct, Pediatric	4
Blood Urea Nitrogen	496
Glucose	957
Amylase, Serum	304
Amylase, Urine	6
Acetone, Serum	39
Salicylate, Serum	11
Barbiturate, Serum	1
Bilirubin/Pediatric	413
Electrolytes-Stat Ion	13473
Sodium	98
Potassium	260
Chloride	93
CO_2	59
Urine Electrolytes-Stat Ion	149
Sodium, Urinalysis	46
Potassium, Urinalysis	29
Sodium, Synovial Fluid	1
Chloride, Synovial Fluid	4
Sodium, Body Fluid	1
Potassium, Body Fluid	1
Chloride, Body Fluid	1
Glucose, Synovial Fluid	2
Magnesium	13
Lipase	58
Lithium	36
Gastric, Fasting	1
Gastric, 15 min	2
Gastric, 30 min	1
Gastric, 45 min	1
Gastric, 60 min	1
Gastric, 75 min	1

TABLE B-12 (cont.)

IMMEDIATE RESPONSE LABORATORY, (*STAT* LABORATORY), FIRST QUARTER 1976, PERIOD Y

Name of Test		Number of Tests Jan., Feb., March 1976
Gastric, 90 min		1
Gastric, 105 min		1
Gastric, 2 hr		1
Urine Amylase		45
Total Vol./ml.-Amylase		32
LDH,CSF		4
	Total	17025
Subtract Standards and Controls		0
Subtract Specimen Collection and Handling		0
Total Tests Requested		17025

TABLE B-13

HEMATOLOGY, FIRST QUARTER 1976, PERIOD Y

Name of Test	Number of Tests Jan., Feb., March 1976
Prothrombin Time (PT)	2339
Partial Thromboplastin Time (PTT)	1966
Platelet Count	1374
Hematocrit and Hemoglobin	76
Bone Marrow Preparation	71
WBC, Model FN	5
Differential	10265
Basophilic Stippling	254
Comment	1
Nasal Smear/EOS	75
Sickle Cell Test	545
Eosinophil Count	121
Euglobulin Lysis	4
NBT	4
Incubated Fragility	5
Reticulocyte Count	1087
Anti-Nuclear Antibody (ANA)	334
ANA Titer Positive	2
Malaria Smear Thin	3
LE Prep	29
Leukocyte Alkaline Phosphatase	14
Acid Test PNH	8
Tourniquet Test	2
Giemsa Stain	49
Clot Retraction	5
Factor Thirteen	1
Fibrinogen	86
Factor Eight	14
Factor Nine	2
Factor Identity	5
Prothrombin Consumption	4
Duke Bleeding Time	124
Lee-White Clotting Time	30
Peroxidase Stain	4
Sedimentation Rate	2062
CSF Hematology	115
Acid Test PNH Sucrose	20
Cell Count, Body Fluid	19
Color/Appearance, Body Fluid	6
Circulating Anticoagulant	1
Unincubated Fragility	23

TABLE B-13 (cont.)

HEMATOLOGY, FIRST QUARTER 1976, PERIOD Y

Name of Test	Number of Tests Jan., Feb., March 1976
Autohemolysin	4
Thrombin Time	19
Fibrin Split Product	35
Fibrinolytic Act	1
Cryofibrinogen	4
Other Blood Parasites	1
Complete Blood Count (CBC) (B40)	2
Morphology-Differential	1
Hematocrit (B40)	1451
CBC-Coulter, FN	383
CBC-Coulter, S	11432
Total	34487
Subtract Standards and Controls	0
Subtract Specimen Collection and Handling	0
Total Tests Requested	34487

TABLE B-14

BACTERIOLOGY/MYCOLOGY, FIRST QUARTER 1976, PERIOD Y

Name of Test	Number of Tests Jan., Feb., March 1976
India Ink	3
Gentamycin	1
Post-Vasectomy Semen Analysis	66
Semen Analysis	40
Media Preparation	44451
Sensitivities	795
Tuberculosis (TB) Culture	2
AFB Smear	2
Specimens Shipped	1
API Test Strip	12380
Biochemicals	1648
Typing	2034
Subculture	3469
Hospital Environmental Survey	1187
CDC Survey	13
ASCP Survey	64
Gram Stain	619
Coagulase	2
Catalase	15
Grouping	8
Fungus Stain	8
Mic-Tube Bul (Sens)	1
Gram Stain (88300)	125
Darkfield Examination	2
Smear, Direct	12
Antibiotic Levels	3
AFB Smear, Direct	27
KOH Prep	16
Fungus Culture, Blood	7
Fungus Culture, Urine	3
PPLO Culture	3
Fungus Culture	108
Miscellaneous Culture	175
AFB Smear Concentrate	5
Synovial Fluid Culture	22
Gastric Fluid Culture	32
Blood Bank Sterility Culture	3
Nasal Culture	293
Ear Culture	29
Blood Culture	497

TABLE B-14 (cont.)

BACTERIOLOGY/MYCOLOGY, FIRST QUARTER 1976, PERIOD Y

Name of Test	Number of Tests Jan., Feb., March 1976
Wound Culture	280
Stool Culture	149
Bone Marrow Culture	2
Throat Culture	8598
Cervical Culture	57
Urethral Culture	13
Vaginal Culture	117
Sputum Culture	332
Eye Culture	78
Nasopharyngeal Culture	5
AFB Culture	39
Urine Culture	4501
Pleural Fluid Culture	19
CSF Culture	63
Blood Smear Direct	7
Abscess Culture	98
Tissue Culture	8
Bronchial with Culture	15
Infectious Control	1
Lochia Culture	5
Abdominal Fluid Culture	19
India Ink Preparation	30
Cord Culture	184
Rectal Culture	11
Lesion Culture	14
Trans Tracheal Culture	8
Anaerobic Culture	30
AFB Smear, Urine	32
AFB Culture, Urine	56
Viral Culture, Urine	2
KOH Preparation, Skin	19
Fungus Culture, Skin	8
Fungus Culture, Nail	1
AFB Smear, CSF	15
AFB Culture, CSF	18
Fungus Culture, CSF	17
Fungus Culture, Abscess	2
KOH Preparation, Vaginal	4
Fungus Culture, Vaginal	9
AFB Smear, Sputum	111
AFB Culture, Sputum	88

TABLE B-14 (cont.)

BACTERIOLOGY/MYCOLOGY, FIRST QUARTER 1976, PERIOD Y

Name of Test	Number of Tests Jan., Feb., March 1976
Viral Culture, Throat	2
Fungus Culture, Synovial Fluid	5
Fungus Culture, Pleural Fluid	11
Urine Direct Smear	7
Urine Gram Stain	13
Feces Direct Smear	2
Feces Gram Stain	9
Eye Direct Smear	1
Eye Gram Stain	1
CSF Gram Stain	44
Exudate Direct Smear	4
Exudate Gram Stain	59
Exudate GC Smear	15
Exudate Culture and Smear	-
Exudate Culture and Sensitivity	490
Abscess GC Smear	1
Abscess Gram Stain	8
Catheter Culture	146
Wound Direct Smear	1
Wound Gram Stain	4
Sputum Direct Smear	2
Sputum Gram Stain	76
Nasal Direct Smear	8
Nasal Gram Stain	1
Bronchial Washing, Gram Stain	2
Synovial Fluid, Direct Smear	3
Synovial Fluid, Gram Stain	10
Pleural Fluid, Gram Stain	13
Sinus Culture	7
Respirator Culture	1
Joint Fluid Culture	6
Lung Culture	4
Kidney Culture	1
Lowboy Whirlpool Culture	1
Hubbard Tank	1
Arm Whirlpool (left)	1
Arm Whirlpool (right)	1
Leg Whirlpool (left)	1
Leg Whirlpool (right)	1

TABLE B-14 (cont.)

BACTERIOLOGY/MYCOLOGY, FIRST QUARTER 1976, PERIOD Y

Name of Test	Number of Tests Jan., Feb., March 1976
Abscess Direct Smear	1
GC Survey-Throat	3
GC Survey-Rectal	3
GC Survey-Vaginal	18
Total	84224
Subtract Standards and Controls	0
Subtract Media Preparation	44451
Subtract Sensitivities	795
Subtract API Test Strip	12380
Subtract Biochemicals other than API	1648
Subtract Typing (serological)	2034
Subtract Subcultures	3469
Subtract Hospital Environmental Survey	1187
Subtract CDC Survey	13
Subtract CAP Survey	64
Subtract Gram Stains done on Subcultures	619
Total	66660
Total Tests Requested	17564

TABLE B-15

URINALYSIS, FIRST QUARTER 1976, PERIOD Y

Name of Test	Number of Tests Jan., Feb., March 1976
Color, Urine	2
Appearance, Urine	2
Specific Gravity, Urine	15
Blood, Urine	2
Bilirubin, Urine	313
Ketones	3
Glucose, Urine	7
Protein, Urine	5
pH, Urine	2
Urobilinogen	14
Comment	16
Urinalysis (UA) Microscopic	8456
Urine Protein, Quantitative	161
Porphyrin	4
Melanogen	1
Bence Jones, Protein	23
Porphobilinogen	13
Urobilinogen, Quantitative	8
Urine, Fasting, GTT	228
Urine, 30 min, GTT	222
Urine, 1 hr, GTT	224
Urine, 2 hr, GTT	224
Urine, 6 hr, GTT	2
Urine, 4 hr, GTT	162
Urine, 5 hr, GTT	138
Urine, 3 hr, GTT	222
Lactose UA Fast	1
Lactose, 30 min	1
Lactose, 1 hr	1
Lactose, 2 hr	1
Lactose, 3 hr	1
Lactose, 4 hr	1
Lactose, 5 hr	1
Coproporphyrins	6
Specific Gravity/B40	6
pH	2
Ketone	1
Glucose	799
Protein	801

TABLE B-15 (cont.)

URINALYSIS, FIRST QUARTER 1976, PERIOD Y

Name of Test	Number of Tests Jan., Feb., March 1976
Urobilinogen	3
Urine Micro/B40	2302
Bile	7
Total	14403
Subtract Standards and Controls	0
Subtract Specimen Collection and Handling	0
Total Tests Requested	14403

TABLE B-16

SEROLOGY, FIRST QUARTER 1976, PERIOD Y

Name of Test	Number of Tests Jan., Feb., March 1976
VDRL CSF	32
Antithyroid Agglutination	3
C-Reactive Protein	20
Mono Spot, Slide	562
RA Test Slide	333
Febrile Agglutination	16
FTA	9
RPR	2715
VDRL	1950
UCG Pregnancy Test, 2 hr	575
Pregnancy Test Quantitative	5
Heterophile, Differential	18
Mono Spot, Quantitative	3
Rubella Titer	281
Anti-Streptolysin 0	112
RA Titer	2
Sperm Agglutination Antibody	3
Cold Agglutination	101
Rubella Titer	9
Cold Hemaglutination	5
VDRL Body Fluid	1
RPR (B-40)	1
Total	6756
Subtract Standards and Controls	0
Subtract Specimen Collection and Handling	0
Total Tests Requested	6756

TABLE B-17

PARASITOLOGY/VIROLOGY,* FIRST QUARTER 1976, PERIOD Y

Name of Test	Number of Tests Jan., Feb., March 1976
Occult Blood	233
Stool, Macroscopic	324
Ova and Parasites	92
Pinworm Preparation	14
Stool pH	8
Trypsin	2
Direct Smear for Ova and Parasites	164
Bile, Stool	156
Fat Stain, Feces	3
Total	996
Subtract Standards and Controls	0
Subtract Specimen Collection and Handling	0
Total Tests Requested	996

*Note: Workload data for this section was compiled using both AFCLAS and log books.

TABLE B-18

BLOOD BANK, FIRST QUARTER 1976, PERIOD Y

Name of Test	Number of Tests Jan., Feb., March 1976
Indirect Coombs	95
Prenatal Antibody Screen	334
Antibody Identity	10
Antibody Titer	8
AB Detection ABO/HDNB	1
Genotype	18
Direct Coombs	278
Rhogam Crossmatch	20
DU	2
Group and Type	1297
Total	2063
Subtract Standards and Controls	0
Subtract Specimen Collection and Handling	0
Total Tests Requested	2063

TABLE B-19

REFERENCE LAB (SPECIMENS SHIPPED), FIRST QUARTER 1976, PERIOD Y

Name of Test	Number of Tests Jan., Feb., March 1976
Coccidiomycosis Test	1
Histoplasmosis Test	1
Pregnanediol	1
Pregnanetroil	3
Magnesium, Urine	1
Heavy Metal	3
5-HIAA	19
Cystine	1
Vanillylmandelic Acid	59
Fecal Fat, 72 hr	26
Leucine-A-Peptidase	2
Alpha Feto Protein	1
Folate	42
Vitamin B-12	35
Leuteninizing Hormone	7
Follicle Stimulating Hormone	13
Testosterone	7
Phenobarbitol	5
Serum Complement Fixation	8
Toxoplasmosis Complement Fixation	33
Insulin Level, Serum	8
Rabies Antibody Titer	3
Mycoplasma CF	1
Immunoglobulin, Electrophoresis	20
Copper, Serum	11
LDH Isoenzyme	13
CPK Isoenzyme	8
Alkaline Phosphatase Isoenzyme	15
HBD	1
Catecholamines	13
Drug Screen	10
Valium	2
Viral Serology Convl.	1
Fungus Battery	5
Total	379
Subtract Standards and Controls	0
Subtract Specimen Collection and Handling	0
Total Tests Requested	379

TABLE B-20

CYTOLOGY, FIRST QUARTER 1976, PERIOD Y

Name of Test	Number of Tests Jan., Feb., March 1976
Hemosiderin	19
Comment, Cytology	11
Cytology Specimen	1955
Total	1985 * (3000)

* This number is incorrect since the February workload was not entered into AFCLAS. (1,985/2) tests per mo. x 3 mo. = 2,976 tests. Use 3,000 as the approximate number of specimens processed.

TABLE B-21

SUMMARY OF THE NUMBER OF TESTS REQUESTED

Laboratory Section	Period X Inpatient Tests	Outpatient Tests	Total Tests	Period Y Total Tests	
Chemistry					
Hospital	34,516	32,538		94,706	Automated
Stat Laboratory	5,539	956		5,644	Manual
Building 40		1,109		17,025	*Stat*
Total	40,055	34,603	74,658	117,375	
Hematology					
Hospital	12,495	19,617			
Building 40		2,262			
Total	12,495	21,879	34,374	34,487	
Bacteriology					
Hospital	8,029	15,734			
Building 40		300			
Total	8,029	16,034	24,063	18,247	* †
Urinalysis					
Hospital	4,144	7,116			
Building 40		2,990			
Total	4,144	10,106	14,250	14,403	
Serology					
Hospital	2,750	4,700			
Building 40		2,000			
Total	2,750	6,700	9,450	6,756	*
Parasitology					
Hospital	657	426	1,083	996	* ‡
Reference Laboratory		0		379	
Grand Total		157,878		192,643	
Cytology				3,000	

* The method for counting workload was significantly changed in Bacteriology, Serology, and Parasitology when AFCLAS was installed. Part of the decrease in workload may be an artifact of this change in the method for counting tests performed.

† Data from AFCLAS Report of Procedures was adjusted based on Bacteriology log books.

‡ Data from AFCLAS Report of Procedures was adjusted based on Parasitology log books.

6. Number of period X slips for inpatients = (total number of period X slips in 1 above) X (percentage in 4 above).

7. Number of period X slips for outpatients = (total number of period X slips in 1 above) X (percentage in 5 above).

8. Number of period Y slips for inpatients = (total number of period Y slips in 3 above) X (percentage in 4 above).

9. Number of period Y slips for outpatients = (total number of period Y slips in 3 above) X (percentage in 5 above).

The total number of slips used in period X was estimated for each laboratory section as follows:

Automated and Manual Chemistry - The CREATE time-sharing system used to generate worksheets in period X keeps statistics on the number of inpatient tests, number of outpatient tests, number of inpatients, and number of outpatients. Assume that a patient only submits one Chemistry slip at a time. Then the total number of Chemistry slips is equal to the total number of patients recorded by the CREATE system.

Stat Laboratory - Obtain the number of slips by counting the number of patients on the daily worksheets (one-to-one correspondence). Assume that inpatient and outpatient slips are divided in the same proportion as are inpatient and outpatient tests.

Hematology - The number of inpatient slips is equal to the number of venipunctures plus finger sticks for inpatients as recorded by the Hematology section.

Similarly, the number of outpatient slips is equal to the number of venipunctures plus finger sticks for outpatients.

Bacteriology - The number of inpatient slips is equal to the number of specimens collected for inpatients as recorded by Bacteriology and similarly for outpatients.

Urinalysis - The number of inpatient slips is equal to the number of specimens collected plus the number of 24-hour Urine Tests (measured) for inpatients as recorded by Urinalysis, and similarly for outpatients.

Serology - First, the mean number of tests per slip is determined by averaging the number of tests on a daily sample of Serology slips and a sample of miscellaneous slips used to request Serology tests (C-Reactive Protein, Rubella Titer, DRL, UCG, Gravindex, Mono Spot). Then the number of inpatient slips is computed by dividing the total number of tests for inpatients by the average number of tests per slip. The number of outpatient slips is computed by dividing the total number of tests for outpatients by the average number of tests per slip.

Parasitology - The procedure for determining the number of inpatient and outpatient slips is similar to that used for Serology. The inpatient, outpatient, and total number of slips estimated for each laboratory section for period X is summarized in Table B-22, along with the total number of slips for each section for period Y and the estimated number of slips for inpatients and outpatients.

TABLE B-22

REQUEST SLIPS

Laboratory Section	Period X Tests per Slip	Period X Total Slips	Period X Inpatient Slips	Period X Outpatient Slips	Period Y Total Slips	Period Y Inpatient Slips	Period Y Outpatient Slips
Chemistry							
Hospital	5.87	11,423	4,227	7,196	17,095		
Stat Laboratory	3.20	2,030	1,746	284	5,320		
Building 40	1.00	1,109		1,109			
Total		14,562	5,973	8,589	22,415	9,194	13,221
Hematology							
Hospital	2.42	13,295	4,840	8,455			
Building 40	1.15	1,967		1,967			
Total		15,262	4,840	10,422	14,913	4,729	10,184
Bacteriology							
Hospital	1.26	18,895	4,830	14,065			
Building 40	1.00	300		300			
Total		19,195	4,830	14,365	14,482	3,644	10,838
Urinalysis							
Hospital	1.03	10,984	3,992	6,992			
Building 40	1.00	2,990		2,990			
Total		13,974	3,992	9,982	14,051	4,014	10,037

TABLE B-22 (cont.)
REQUEST SLIPS

Laboratory Section	Period X Tests per Slip	Period X Total Slips	Period X Inpatient Slips	Period X Outpatient Slips	Period Y Total Slips	Period Y Inpatient Slips	Period Y Outpatient Slips
Serology							
Hospital	1.19	6,261	2,311	3,950			
Building 40	1.00	2,000		2,000			
Total		8,261	2,311	5,950	5,677	1,588	4,089
Parasitology							
Hospital	1.42	763	463	300	701	425	276
Reference Laboratory	-	-	-	-	379	190	189
Grand Total		72,017	22,409	49,608	72,618	23,784	48,834

E. Number of Request Cards in Period Y

All test request cards, admit cards (includes admit cards and registration cards), and test result cards were collected for a period ranging from 7 days to 31 days in period Y. Based on the cards that were collected, we computed the average number of tests per request card by laboratory section. The number of tests per coagulation card was computed separately. We also counted differential result cards and admit cards.

We measured the number of inches (height) of cards and estimated the total number of cards using the factor 1 inch = 150 cards. As a check on the data collection, we compared the estimate of 10,478 differential cards used with the 10,265 differential tests performed as recorded by AFCLAS (error of 213 in 10,000).

The number of cards estimated to be used are summarized in Table B-23. We assumed that request cards are divided between inpatients and outpatients in the same ratio as period X request slips. Hence we assumed that 33 percent of requests are for inpatients. Therefore, of the total 55,857 request cards, 18,294 cards were assumed to be for inpatients and 37,563 cards were assumed to be for outpatients.

F. Number of Pages of AFCLAS Reports

The number of pages of AFCLAS reports was counted each evening during period Y. Averaged over 27 days, the mean number of pages was 773.4 pages per day. We assumed that pages of reports were divided between inpatients and outpatients in the same ratio as were period X request slips. Hence 33 percent of the reports were estimated to be for inpatients.

$$\left(\begin{array}{c}\text{773.4 pages}\\ \text{per day}\end{array}\right) \times \left(\begin{array}{c}\text{90 days in}\\ \text{period Y}\end{array}\right) = \text{69,606 pages in period Y.}$$

$$\left(\begin{array}{c}\text{69,606 pages}\\ \text{in period Y}\end{array}\right) \times \left(0.328\right) = \text{22,818 pages in period Y for inpatients.}$$

TABLE B-23

NUMBER OF COMPUTER REQUEST CARDS

Type of Card	Number of Cards
Test Request Cards	
Chemistry	
Hospital	8,072
Building 40	--
Total	8,072
Hematology	
Hospital	11,985
Building 40 (assume one card for each test)	1,453
Coagulation	2,561
Total	15,999
Bacteriology (includes Parasitology)	
Hospital	15,814
Urinalysis	
Hospital	8,193
Building 40	2,308
Total	10,501
(Routine Urine Tests performed)	(10,764)
Serology	
Hospital	4,829
Reference Laboratory	379
Total Test Request Cards	55,857
Inpatient Test Request Cards	18,294
Outpatient Test Request Cards	37,563
Differential Cards	10,478
Admit Cards	36,837
Cytology	3,000

(69,606) X (0.672) = 46,788 pages in period Y for outpatients.

G. Number of Inpatient Reports in Period Y

In period Y a random sample of 241 inpatient reports was drawn for the inpatient records search. These reports contained 528 pages.

$$\frac{528 \text{ pages}}{241 \text{ inpatient reports}} = 2.19 \text{ pages per inpatient report.}$$

Therefore, in period Y,

$$\frac{22{,}818 \text{ pages of inpatient reports (Section F)}}{2.19 \text{ pages per inpatient report}} = 10{,}415 \text{ inpatient reports.}$$

H. Number of Admissions for January, February, March 1976

The number of admissions as reported by month on AF Form 235b (Report of Patients - Hospital Supplement) for 1976 was as follows:

January	731
February	711
March	790
Total admissions	2,232

I. Number of Blood Collection Tubes in Period Y

The number of evacuated blood collection tubes used per day in period Y was derived in Section B, Task 16 of Appendix C.

667.9 tubes per day X 90 days in period Y = 60,113 tubes in period Y .

J. Number of Patients for Automated Chemistry in Period Y

The number of patients requesting Automated Chemistry tests (HYCEL-17 requests) in period Y was estimated to be the following:

HYCEL-17 panels	4,931
Glucose (2 hour)	1,178
Miscellaneous	1,000
Total patients	7,109

K. Number of Inquiry Telephone Calls

The frequency of inquiry telephone calls in period X, the frequency in period X adjusted for workload, and the frequency for period Y were as follows:

Period X	5.5 calls per hour
Period X adjusted for workload	6.7 calls per hour
Period Y	4.6 calls per hour.

These frequencies were converted to total calls by multiplying by 9 hours per day and 62 normal workdays per quarter. The total calls were as follows:

Period X	3,069 telephone inquiry calls
Period X adjusted	3,739 telephone inquiry calls
Period Y	2,567 telephone inquiry calls.

L. Number of MAMS-R Transactions in Period Y

The location of all inpatients must be stored in the AFCLAS system so that reports are identified with the proper ward location. The MAMS-R system was in operation at MCWP during period Y so that each time an admission, discharge, or interward transfer was entered into MAMS-R, a copy of the transaction was printed for use by the AFCLAS computer operators to enter the data into AFCLAS. As given in Section H the number of admissions for January, February, and March 1976 totaled 2,232. We assumed that the same number of patients that was admitted during this period was also discharged so that the number of discharges for January, February, and March 1976 was assumed to be 2,232 also.

The average number of interward transfers during period Y was 6.78 interward transfers per day.

The total number of admissions, discharges, and interward transfers was as follows:

Admissions	2,232
Discharges	2,232
Interward transfers (6.78 interward transfers per day X 90 days in period Y)	610
Total	5,074

M. Number of Patients Arriving at the Reception Desk in Period Y

During the MET data collection times in period Y, a sample of 346 outpatients arrived at the reception desk with 763 test request cards.

$$\frac{763 \text{ cards}}{346 \text{ outpatients}} = 2.21 \text{ cards per outpatient}$$

$$\frac{37{,}600 \text{ total outpatient cards}}{2.21 \text{ cards per outpatient}} = 17{,}014 \text{ total outpatients.}$$

The number of outpatients arriving at the reception desk is equal to the total number of outpatients having tests requested minus the number seen in the Building 40 clinic.

Total number of outpatients	17,014
Building 40 outpatients seen	- 3,000
Outpatients arriving at the reception desk.	14,014

N. Cost Per Personnel Category

The cost for each personnel category is derived in this section. For each personnel category, we first determined the number of personnel at each rank or GS grade in the category. Next we calculated the average cost for the personnel category by computing a weighted average of the direct cost to the Air Force for all personnel in the category. We based military personnel rates on the Air Force Annual Composite Standard Rate, and we based Civil Service personnel rates on 108.44 percent [Ref. 1] of Step 4 of the GS pay scale, both as of 1 October 1975. We then calculated the hourly and quarterly rates for each category from the annual rate.

1. Laboratory Personnel

For laboratory staff we used authorized staff rather than assigned staff, because in several cases the rank of personnel assigned was different than what is specified in the manning standard. Table B-24 shows the authorized manning for the clinical laboratory at MCWP for the spring of 1976. It also

TABLE B-24

LABORATORY STAFF

Grade	Number Authorized	Annual Cost Per Grade
Lieutenant Colonel (O-5)	1	$29,249
Captain (O-3)	3	20,751
Senior Master Sergeant (E-8)	1	16,291
Master Sergeant (E-7)	1	14,360
Technical Sergeant (E-6)	2	12,336
Staff Sergeant (E-5)	10	10,550
Sergeant (E-4)	10	9,031
Airman First Class (E-3)	5	7,275
GS-10	1	17,682
GS-9	3	16,081
GS-8	1	14,578
GS-7	1	13,175
GS-6	2	11,866
GS-5	1	10,648
GS-4	4	9,515

gives the annual cost for each grade. Phase II (job training for laboratory technicians) students were not included in the computation of personnel cost because they are not included in hospital manning.

Starting with the authorized manning for the entire laboratory, we defined the personnel categories of Laboratory Officer, NCOIC, Laboratory Supervisor, and Laboratory Technician. We then calculated the annual cost per category as shown.

Laboratory Officer. This category included all officers as follows:

1 Lieutenant Colonel (O-5)	$29,249
3 Captain (O-3)	62,253
4 Total	$91,502

Average salary for Laboratory Officer =

$\frac{\$91,502}{4}$ = $22,876 per year.

NCOIC. This category included only a Senior Master Sergeant (E-8) at an average annual cost of $16,291.

Laboratory Supervisor. The personnel in this category were as follows:

1 Master Sergeant (E-7)	$14,360
1 GS-10	17,682
2 GS-9	32,162
1 GS-8	14,578
5 Total	$78,782

Average salary for Laboratory Supervisor =

$\frac{\$78,782}{5}$ = $15,756 per year.

Laboratory Technician. The personnel in this category were as follows:

1	Master Sergeant (E-7)	$ 14,360
2	Technical Sergeant (E-6)	24,672
10	Staff Sergeant (E-5)	105,500
10	Sergeant (E-4)	90,310
5	Airman First Class (E-3)	36,375
1	GS-10	17,682
3	GS-9	48,243
1	GS-8	14,578
1	GS-7	13,175
2	GS-6	23,732
1	GS-5	10,648
4	GS-4	38,060
41	Total	$437,335

Average salary for Laboratory Technician =

$\frac{\$437,335}{41}$ = $10,667 per year.

AFCLAS Systems Manager. This position could be filled by either a captain (O-3) or a major (O-4). Therefore, $20,751, the annual cost of a captain, was used in the analysis.

Data Base Maintenance and Routine Administration. During period Y a staff sergeant (E-5) performed this task and devoted half-time to it. Hence,

annual cost = $\frac{\$10,550}{2}$ = $5,275.

Computer Room Staff. Because of the size and complexity of AFCLAS, the computer room must be manned 24 hours a day, 7 days a week. According to the manning standard of the MET, this requires a minimum of five military personnel. We chose the rank distribution for computer operators, as follows, after consultation with TRIMIS Program Office (TPO) personnel

1	Technical Sergeant (E-6)	$12,336
1	Staff Sergeant (E-5)	10,550
3	Sergeant (E-4)	27,093
5	Total	$49,979

During period Y laboratory technicians and civilians served as computer operators. Using laboratory technicians does not affect the above cost as long as the rank distribution shown above is maintained. Civilian computer operators generally cost more than military operators; thus, the figure of $49,979 represents a minimum expected cost.

Reception Personnel. The MET estimated by direct observation in period Y that an additional two and one-half receptionists would be required to perform the new tasks related to AFCLAS. We chose the GS grade distribution for the receptionists after consultation with TPO personnel as follows:

1	GS-4	$ 9,515
1 1/2	GS-3 @ $8,472	12,708
2 1/2	Total	$22,223

2. Ward Nurse

The nursing staff on the ward is composed of predominantly first lieutenants (O-2) and captains (O-3) with some majors (O-4) and second lieutenants (O-1). On wards with a staff of several nurses, the lower ranking officers are more likely to do the processing of laboratory tests. Therefore nursing staff are costed at the pay rate for a first lieutenant (O-2) at $16,247 per year.

3. Inpatient Medical Records (IMR) Staff

The staff of IMR is composed primarily of GS-3s, GS-4s, and GS-5s. Observation indicated that the majority of tasks involving laboratory reports were performed by a GS-4. Hence IMR staff is costed at the GS-4 rate of $9,515 per year.

4. Clinic Staff

The clinic staff is a large group of personnel composed of both civilians and military. It includes entry level personnel through supervisory personnel. The filling out of request slips, request cards, and admit cards is done by all levels of clinic staff with the lower level staff doing

more than the senior staff. We costed clinic staff at $9,031 per year, the rate for a sergeant (E-4).

5. Admissions and Disposition (A&D) Staff

Based on direct observation, this task was usually performed by a sergeant (E-4) at the rate of $9,031 per year.

6. Corpsman

The corpsmen are low ranking military personnel; hence they were costed at the rate for an airman first class, which is $7,275 per year.

7. Outpatient Medical Records (OMR) Staff

All the OMR staff participate in the processing of loose paperwork, which includes filing of laboratory slips. In order to be conservative, we used the rate for an airman first class (E-3) which is $7,275 per year.

8. Patient

Patient time has value to the patient and in some cases value to the Air Force. However, it was not considered to have value to the Air Force Surgeon General. Since we investigated costs and savings that are part of the cost of the delivery of military medical care, we assigned no dollar cost to patient time. Lost patient time was considered to be a direct budget cost to the Air Force Surgeon General.

REFERENCES

(1) U.S. Department of the Air Force. AFM 26-1—Manpower Policies and Procedures. Washington, D.C.: Headquarters U.S. Air Force, May 1973.

APPENDIX C

SUMMARY OF THE TIME STUDIES DATA COLLECTED BY THE MANAGEMENT ENGINEERING TEAM AT WRIGHT-PATTERSON AFB

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This appendix presents a summary of the data on time studies collected by the Management Engineering Team (MET) at Wright-Patterson AFB, as well as other related information. Statistical data such as procedures performed, number of inpatient bed-days, and outpatient visits are given in Appendix B. All sections (beginning with Section A) were written by the MET with the exception of Table C-1 and Table C-2.

Table C-1 summarizes the time studies performed by the MET, and Table C-2 gives the category of personnel performing the tasks time studied. Section A gives the data collected in period X, Section B gives the data collected in period Y, and Section C gives additional miscellaneous information.

The MET made the numerical estimates presented in this appendix for each category of personnel performing the tasks time studied based on data collected while making the time measurements and on direct observation of the operation of the laboratory and the hospital during the 3-month interval for training, orientation, data collection, and follow-up in periods X and Y. Since the average salary for laboratory technicians, receptionists, Inpatient Medical Records Staff, clinic staff, Admissions and Dispositions staff, corpsmen, and computer operators varies by only 19 percent, the costs associated with the time studies are not sensitive to small errors in assignment of the personnel categories listed.

Some of the computations for the workload figures presented in this appendix are preliminary estimates that were not used in the analysis (with the exception of the computations for Task 16). The workload figures used in Table III-2 are derived in Appendix B.

A. Period X

1. Description of Data Collection

A workday for data collection purposes ran from 1700 hours each day until 1700 hours the following day. At that time the

 (Text continues on page 176.)

TABLE C-1

SUMMARY OF TIME STUDIES FOR EVALUATION OF AFCLAS

Task	Time Measurement	Items Counted	Associated Hypotheses
1. Tasks involved in preparation of administrative reports and College of American Pathologists (CAP) workload reports	Time per task accomplishment for each task	Number of times during Period X that each task is done	1, 10
2. Filing request slips in laboratory files	Time per request slip	Request slips	6
3. Filing test worksheets and workload log sheets in laboratory files by laboratory section and centrally	Time per page	Test worksheets and workload log sheets, by laboratory section	6
4. Filing quality control reports/ statistical summaries in laboratory files	Time per report produced, by laboratory section	Number of times reports are produced, by laboratory section	6
5. Other laboratory filing tasks	As appropriate	As appropriate	6
6. Removing outdated items from laboratory files for each kind of file	Time per task accomplishment, by kind of file	Number of times outdated slips are removed from files, by kind of file	6
7. Filing laboratory results in outpatient medical records	Time per slip	Request slips for outpatients	7
8. Filing laboratory results in the medical records of inpatients (a) on wards (b) in medical record room	Time per slip (a) on wards (b) in medical record room	Request slips for inpatients and (a) percent filed on wards (b) percent filed in medical record room	8

TABLE C-1 (Cont.)

SUMMARY OF TIME STUDIES FOR EVALUATION OF AFCLAS

Task	Time Measurement	Items Counted	Associated Hypotheses
9. Preparing and filing cumulative summaries or flow sheets of patient results	Time per patient	Percent inpatients for whom it is done	55
10. Filling out request slips at clinics and wards	Time per slip	Request slips	9, 51
11. Filling in laboratory request information on slips by laboratory personnel	Time per slip	Number of slips and percent filled in by laboratory personnel	9
12. Entering test results on slips	Time per test	Number tests by kind	9, 13, 14, 18, 19, 29
Period X: (a) printed automatically	type (a)	(a) kinds type(a)	
Period X: (b) transcribed from worksheets or log books	type (b)	(b) kinds type(b)	
Period X: (c) transcribed from instrument display	type (c)	(c) kinds type(c)	
Period X: (d) transcribed from printout	type (d)	(d) kinds type(d)	
Period Y: (a) online			
Period Y: (b) manually entered into terminal from worksheets			
Period Y: (c) mark-sense worksheets			
Period Y: (d) mark-sense computer card			
13. Entering headings on test worksheets, workload log sheets, log book pages	Time per sheet or log book page	Test worksheets, workload log sheets, and log book pages	9, 29

TABLE C-1 (Cont.)

SUMMARY OF TIME STUDIES FOR EVALUATION OF AFCLAS

Task	Time Measurement	Items Counted	Associated Hypotheses
14. Entering patient identification and tests requested on test worksheets, workload log sheets and in log books (except Chemistry worksheets at W-P)	Time per entry, by type of sheet/log book	Test worksheet, workload, log sheet, and log book entries	9, 29
15. Entering results on test worksheets, workload log sheets, and log books, types (a), (b), (c), (d), in 12 above	Time per test types (a), (b), (c), (d), in 12 above	Worksheets, workload, log sheets and log books types (a), (b), (c), (d), in 12 above	9, 13, 14, 29
16. Labeling specimen tubes	Time per tube	Tubes labeled	11
17. Preparing "list" for routine specimen collection trips (sorting slips for technicians who collect the specimens)	Time per routine trip	Number of routine trips per day and number of technicians making trip	12
18. Supervisor's and technician's review and certification of results	Time per test, request slip, worksheet or other unit certified	Number tests, request slips, worksheets, or other units certified	20, 21
19. Performing statistical analysis of quality control sample results and recording results on report	Time per task accomplishment, by laboratory section	Number of times statistics are calculated, by each laboratory section and by each kind of report	22, 23, 24

TABLE C-1 (Cont.)

SUMMARY OF TIME STUDIES FOR EVALUATION OF AFCLAS

Task	Time Measurement	Items Counted	Associated Hypotheses
20. Performing statistical analysis of patient results by population	Time per analysis	Number of analyses performed	25, 26
21. Performing test result calculations or conversions	Time per test, by kind	Tests, by kind for which calculations are done	27
22. Performing computer operation tasks (W-P)	Time per task accomplishment for each task	Number of times each task is done (per day, week, or month)	28
23. Calling a ward or clinic to report the results of a *stat* test (Consider calls originating in *stat* laboratory, hematology, and urinalysis.)	Time per telephone call	Number of telephone calls to report stat results	56
24. Supervisor's (laboratory officers) responding to inquiries, complaints, and errors	Time per supervisor	As appropriate	53
25. Processing inquiry phone calls to the laboratory	Time per telephone call	Number of inquiry calls to the laboratory	2, 3, 4
26. Retrieval of data to answer inquiries for call backs and completing the return calls	Time per telephone inquiry	Number of inquiries requiring a return call	3

TABLE C-1 (Cont.)

SUMMARY OF TIME STUDIES FOR EVALUATION OF AFCLAS

Task	Time Measurement	Items Counted	Associated Hypotheses
27. Reviewing or processing new AFCLAS-generated reports	Time per report	Frequency of each report	58
28. Addition of Cytology to AFCLAS reporting system	Time per cytology report	Number of reports	11, 14
29. Preparing a list of admissions and interward transfers for laboratory use with AFCLAS	Time per transaction	Number of admissions, dispositions, and interward transfers	57

TABLE C-2

CATEGORY OF PERSONNEL PERFORMING

TASKS THAT WERE TIME STUDIED

Task *	Period X	Period Y
1	100% Noncommissioned Officer in Charge (NCOIC)	100% NCOIC
	100% Laboratory Officer	100% Laboratory Officer
	100% Laboratory Supervisor	100% Laboratory Supervisor
2	50% Laboratory Supervisor	50% Laboratory Supervisor
	50% Laboratory Technician	50% Laboratory Technician
3	100% Laboratory Supervisor	100% Laboratory Supervisor
4		
a. Chemistry	100% Laboratory Officer	100% Laboratory Officer
b. Other	100% Laboratory Technician	100% Laboratory Technician
5		
a. Microbiology	60% Laboratory Supervisor	60% Laboratory Supervisor
	40% Laboratory Technician	40% Laboratory Technician
b. Report of Patients	Not done in period X	
Daily		100% NCOIC
Monthly		100% NCOIC
c. Filing Tasks Inside Computer Room	Not done in period X	100% Computer Operator
6	100% Laboratory Technician	Not done in period Y
7	100% Outpatient Medical Records (OMR) Technician	100% OMR Technician

* See Table C-1 for task descriptions.

TABLE C-2 (cont.)

CATEGORY OF PERSONNEL PERFORMING

TASKS THAT WERE TIME STUDIED

Task	Period X	Period Y
8		
a. Wards	50% Nurse 50% Corpsman	30% Nurse 70% Corpsman
b. Inpatient Medical Records (IMR)	100% Civilian IMR Staff GS - 4	100% Civilian IMR Staff GS - 4
9	100% Physician	100% Physician
10		
a. Outpatients	10% Clinic Staff 90% Outpatient	100% Clinic Staff
b. Inpatients	100% Nursing Staff	100% Nursing Staff
11	40% Receptionist 60% Laboratory Technician	100% Receptionist
12	100% Laboratory Technician	100% Laboratory Technician
13	100% Laboratory Technician	100% Laboratory Technician
14	100% Laboratory Technician	100% Laboratory Technician
15	100% Laboratory Technician	100% Laboratory Technician
16	100% Laboratory Technician	100% Laboratory Technician
17	100% Laboratory Technician	100% Laboratory Technician

TABLE C-2 (cont.)

CATEGORY OF PERSONNEL PERFORMING

TASKS THAT WERE TIME STUDIED

Task	Period X	Period Y
18	100% Laboratory Supervisor	100% Laboratory Supervisor
19 Chemistry	75% Laboratory Officer 25% Laboratory Technician	75% Laboratory Officer 25% Laboratory Technician
20	100% Laboratory Officer	100% Laboratory Officer
21	100% Laboratory Technician	100% Laboratory Technician
22	100% Laboratory Technician	Not done in period Y
23	100% Laboratory Technician 70% Nursing Staff 30% Technician or Ward Clerk	100% Laboratory Technician 50% Nursing Staff 50% Technician or Ward Clerk
24	100% Laboratory Officer	100% Laboratory Officer
25	100% Laboratory Technician 100% Nursing Staff	100% Laboratory Technician 100% Nursing Staff
26	100% Laboratory Technician	100% Laboratory Technician
27	Not done in period X	100% Laboratory Technician
28	Not done in period X	100% Laboratory Supervisor
29	Not done in period X	100% Admissions and Dispositions (A&D) Staff

date was changed on the Xerox machine and Forms 3, 5, and 12 (see Appendix F) were exchanged.

Ward searches for inpatient slip samples were begun at approximately 1800 hours each day. The Admissions and Dispositions Office was checked first before proceeding to the nursing wards.

Slips from Outpatient Medical Records (OMR) were obtained and Xeroxed at 1200 hours for the first 3 days. After that they were obtained and Xeroxed at 0900 hours before the slips had been placed in numerical order (by Social Security number) by the OMR staff. This change had no significant impact on study results.

Data collection forms were arranged in numerical order by day. During the first few days of period X, if there were no entries on a form it was not retained. Later in the study it was decided to include blank forms to avoid the appearance of missing forms.

A typical day for the data collectors ran from 0700 hours to about 1930 hours. One man would arrive at 0700 hours and handle morning sampling of slips, Xeroxing of outpatient records slips, Xeroxing of laboratory request slips, and distribution and collection of both patient questionnaires and "turn-around time" cards. The second man began work at approximately 1100 hours. He assisted his coworker as required, completed the personnel assignment sheet, collected outpatient visit data, and began cutting and sorting Xeroxed slips. He also prepared the forms for the following day and collected and distributed them at the proper time. An additional responsibility of the data collectors was to keep abreast of significant changes, conditions, and events within the laboratory and with respect to laboratory procedures. Their observations were recorded

in a daily journal. Both data collectors participated in the selection and searching for the sample of Xeroxed request slips. Approximately 20 man-hours were expended during each day of period X.

2. Results of Time Studies by Task*

Task 1. Administrative, CAP, Workload, and Other Types of Reports.

a. Preparation and consolidation of workload reports from laboratory sections:

- monthly report - 6 hr. to compile and submit.
- quarterly AF Form 235 - an additional 4 hr. to consolidate monthly reports every third month. 4 X 0.33 = 1.32 hr. per month.

b. CAP workload and survey reports. Data collected from other reports and reformatted. 3 hr. per month including secretarial time.

c. Bacteriological reports (see Task 5)

- Positive Beta Strep List - 15 min. daily. 0.25 hr. X 20.99 days = 5.25 hr. per month.
- Environmental Surveys - 45 min. per wk. to complete. 0.75 hr. X 4.35 wk. = 3.26 hr. per month.
- Communicable Disease Report - 45 min. per week. 0.75 hr. X 4.35 wk. = 3.26 hr. per month.
- Antibiogram Report - 5 hr. per month to compute and complete.

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* See Table C-1 for task descriptions.

Task 2. Filing Request Slips in Laboratory Files.

This task is accomplished in the same fashion in each of the following laboratory sections: Hematology, Urinalysis, *Stat* Laboratory, Special Chemistry, and Chemistry. Bacteriology/Microbiology filing system differs in that slips are filed twice; they are filed once while culture awaits reading, and then refiled after results are recorded. The filing time is approximately twice that of other sections. Average time to file slips was measured to be 0.046, 0.068, 0.05, 0.05, and 0.048 minutes, respectively, for the laboratory sections listed above. The time of 0.05 min. per slip should be used for all sections, except for Bacteriology/Microbiology, which should be 0.10 min. per slip. To obtain total filing time, the total number of request slips must be determined from the workload reports. This was done in the following manner:

Hematology: Total of venipunctures plus finger sticks = Total slips.

Urinalysis: Total specimens received = Total slips.

Stat Laboratory: Total line entries on worksheets = Total slips.

Chemistry: Total of inpatients and outpatients from monthly report plus entries in shipping log = Total slips.

Special Chemistry: Not applicable (reported with Chemistry).

Coagulation: Not applicable (reported with Hematology).

Bacteriology/Microbiology/Serology: Total log entries for all workload logs (based on number of inpatient and outpatient procedures where 77 percent of log entries are for outpatients).

Task 3. Filing Worksheets, Log Sheets, etc.

Generally speaking, filing consists of laying 1 month's sheets on top of the previous months' sheets; no real formal filing process exists.

This task was loosely interpreted to mean disposing of worksheets by whatever method necessary, excluding throwing them away.

Time required = 1 min. per day for each of the following sections: *Stat* Laboratory, Coagulation, Bacteriology/Microbiology.

= 2 min. per day for Chemistry.

= 1 additional min. per month to relocate from a daily to a permanent file for each of the following: Hematology, Urinalysis, *Stat* Laboratory, Coagulation, Chemistry, Special Chemistry, Bacteriology/Microbiology

Tasks 4 and 19. Quality Control Reports and Statistical Summaries.

In the Chemistry section, statistical quality control is handled by sending the results of tests performed on controlled laboratory standards to manufacturing companies (either Hyland or Dade). The results are then analyzed by the company, and a large (approximately 100-page) computer printout is sent back to the laboratory. The monthly statistical reports are reviewed by the laboratory officers and filed in the office of the Officer in Charge of Chemistry. The Officer in Charge of Chemistry is responsible for preparing the data for submission and filing the reports.

The time required for the activities related to quality control is as follows:

- Preparation of data: 2 hr. per wk. X 4.35 wk. per month = 8.7 hr. per month.
- Review of completed analysis: 25 hr. per month.
- File statistical reports: 2 min. per month.

The data were compiled and submitted to Hyland and Dade for January, February, and March, 1975, but no analysis was received because the values were so variable due to equipment changes. Monthly comparisons of this data would have been meaningless.

In addition, the *Stat* Laboratory maintains graphs of the results from testing control specimens for eight different tests: Amylase, Total Bilirubin, Sodium, Potassium, Chloride, Carbon Dioxide, Glucose, and Bun. Time expended to post graphs = 2.5 min. per day posted.

Entries during period X = five or 12.5 min. per month.

Average number of entries per mo. = 20 or 50 min. per month.

File graphs at end of month = 1 min. per month.

For the *Stat* Laboratory the reason so few entries were made for March is that the NCOIC of Chemistry was on leave, and no one insisted that the graphs be posted.

Task 5. Other Laboratory Filing.

a. Environmental Survey - Approximately 400 specimens are received and processed per month to identify harmful bacteria in hospital surroundings. Time to prepare the report is included in Task 1. Time to file the reports is 5 min. per wk.

b. Communicable Disease Report - A summary of all infection specimens whose results are positive.

The report is prepared weekly (45 min. each) and time is included in Task 1. Time to file reports is 5 min. per week or 21.75 min. per month (5 min. per wk. X 4.35 wk. per mo. = 21.75 min. per mo.).

c. Antibiogram Report - Records results from testing various antibiotics on cultured specimens. This report is prepared monthly from the daily log and maintained cumulatively. Time to prepare is included in Task 1. Time to file is 15 min. per mo.

d. Positive Beta Strep List - Daily listing of all positive beta streps. This list is sent to the Emergency Room for their notification of appropriate patients. Time to prepare is 15 min. per day included in Task 1. Time to file is 1 min. per day or 1 min. per day X 20.99 workdays per mo. = 20.99 min. per mo.

Task 6. Remove Outdated Items From Laboratory Files.

At the end of each month files of laboratory slips are moved from Hematology, *Stat* Laboratory, Chemistry, Urinalysis and Special Chemistry to a central filing cabinet in the rear of the laboratory, where they are filed by section, alphabetically, in approximate chronological order. Time required per section is 15 min. per mo.

In Bacteriology/Microbiology, files are not moved to the cabinet in the rear of the laboratory, but they are moved within the same cabinet. Time required is 5 min. per mo.

Task 7. Filing Laboratory Results in Outpatient Medical Records.

The following is a breakout of the tasks and times for placing laboratory slips into outpatient records. Starting with 100 slips:

a. Write last 4 digits of Social Security number on slip with felt pen for easier reading. (Four of the 100 slips had improper identification and were placed in missing-information box.)

9.11 min. ÷ 96 slips = 0.095 min. per slip.

b. Separate slips by next-to-last digit.

2.53 min. ÷ 96 slips = 0.026 min. per slip.

c. Separate slips by last digit and place in appropriate boxes.

8.10 min. ÷ 96 slips = 0.084 min. per slip.

d. Place slips in medical records. Twelve slips had no record.

33.60 min. ÷ 84 slips = 0.40 min. per slip.

e. Staple slips in record. Three slips placed in brown folders since files were out.

33.82 min. ÷ 81 slips = 0.418 min. per slip.

f. Place unfilable slips in proper place.

7.21 min. ÷ 19 slips = 0.380 min. per slip.

Therefore, time to file one average slip = 0.095 + 0.026 + 0.084 + 0.40 + 0.418 = 1.023 min., and, 1.023 min. per slip X (number of slips filed) + 0.380 min. per slip X (number o unfilable slips) = total filing time.

Frequency for filing can be determined by taking the average of the number of OMR slips Xeroxed or, alternately, by computing the average number of all slips filed. (The frequency for filing that was used in the analysis is deriv in Section D of Appendix B.)

Task 8A. Filing of Results Slips on Wards.

a. On the wards, laboratory slips are handled in t different ways:

- Original filed directly in patient's record; physician copy discarded or piled in basket. This procedure is applicable for wards 2E, I 3N, 3W, and 5W.
- Original filed directly in patient's record; physician copy filed in individual physician box or bin. This procedure is applicable fo wards 1N, 2N, 3S, and 5S.
- Slip filed in physician's box for signature; then collected, and original filed in patien record. This procedure is applicable for wa 2S, 2W, 4S, and 4W.

As outlined in the backup data on the following pag there appears to be little significant difference in the expended by ward personnel among the different methods. real difference is in the time it takes a slip to get in patient's record, and this is caused by the standby time while the slip is waiting to be signed. The MET recomme ation is to apply the same time to all slips, regardless ward, i.e., 0.457 minutes. Estimating total slips at 17 day results in 0.457 min. per slip X 175 slips per day =

79.975 min. per day
\+ 5.50 min. per day (1.25 X 4 wards) + (0.10 X 5 wards)
= 85.48 min. per day to file inpatient sli

Filing of Result Slips on Wards - Backup Data:

a. Separate slips.

1.380 min. ÷ 13 slips = 0.106 min. per slip.

b. File in physician's box (individual).

0.85 min. ÷ 23 slips = 0.037 min. per slip.

c. Stack in physician's basket (general).

0.10 min. total, done approximately once each day.

d. Collect slips from physician's boxes.

1.25 min. per day.

e. File original copy in record.

7.50 min. ÷ 23 slips = 0.326 min. per slip.

Methods: a + c + e = (0.432 X number of slips) + 0.10

a + b + e = 0.469 X number of slips

b + d + a + e = $\frac{(0.469 \text{ X number of slips}) + 1.25}{1.370 \text{ min. per slip}}$

1.370 min. per slip ÷ 3 = 0.457 min. per slip

[(1.25 X 4 wards) + (0.10 X 5 wards)]

$$\left(\begin{array}{l}0.457 \text{ min.} \\ \text{per} \\ \text{slip}\end{array} \text{ X } \begin{array}{l}\text{number of} \\ \text{inpatient} \\ \text{slips}\end{array}\right) + 5.50 \text{ min.} = \text{Total min. per day file inpatient sli}$$

Task 8B. Filing of Results Slips in Clinical Records Sec (CRS).

When a patient is discharged, nursing personnel carr the medical record to the Clinical Records Section.* An

* This system was established 24 March 1975. Prior to t records for discharged patients were sent to Admission and Dispositions (A&D) and personnel there put the inf mation in the record in order. After that the record taken to CRS.

laboratory slips that come to the ward after that are
to CRS. The slips are placed in a box with all other
paper and filed the next day in temporary folders. The
must be processed to assure that all necessary informat
present. This requires between 3 and 6 weeks. When th
record is completed, the paper work is transferred fro
temporary folder to the record, which is filed on the
by patient hospital number. Any loose paper coming in
the record has been filed is placed directly into the

Slip Processing Time in CRS:

a. File slip in temporary folder (done along with
other loose paper): 0.50 min. per slip, 64.6
per day or 32.30 min. per day.

b. Search files for proper patient hospital numbe
when missing. Approximately 4 percent missing
all incoming slips or 2 per day. About 0.75
to find each or 1.50 min. per day.

c. Place loose paper from temporary folder in fi
record (done along with other paper). Thirty
per day at 1 min. per record is 30 min. per da

d. Place slip in record after record has been fi
Three records per wk. at 2.5 min. per record
7.5 min. per wk. or 1.5 min. per day.

Total is 65.3 min. per day to file laboratory resu
slips in CRS. 65.3 min. per day X 62 days per mo
60 min. per hr. = 67.5 hr. per mo.

Note: Times above include work on laboratory slips onl
Where other items were mixed with laboratory wo
percentage distribution was made to eliminate no
laboratory workload.

Task 9. Prepare and File Flow Summaries or Cumulative Summaries of Patient Results.

In general terms, written flow summaries (flows) a prepared for most critical care patients, patients with persistent problems, and certain unusual cases. Inform cumulative flow summaries are done mentally almost ever time a consulting physician reviews a case for a reside or intern, but many of these are not written down. Wh doing ward searches for laboratory test results, very f written summaries were observed; about 8 to 10 were fou while we searched for 400 laboratory slips. Some recor awaiting physician administrative action in Clinical Re Section were reviewed, and flows were found in two out 15 cases. Physicians interviewed estimated that writte summaries were accomplished on 15 to 20 percent of all and that mental summaries were done on at least 50 perc the patients.

Time to initiate written flow = 3 min. (Usually t done after several days of reports have accumulated.)

Time to maintain flows = 5 min. per wk.

Normal process is to post the form with several re at the same time. Flows are rarely maintained for more 2 weeks, and are done entirely by the physicians.

Time required for each written flow = 3 min. to i + 5 min. maintenance per wk. X 2 wk.

Therefore, the average cost in physician time of a wri flow summary is approximately 13 minutes. It is estim that about 15 percent of the inpatients at any one tim written flows in their record.

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EVALUATION OF THE AIR FORCE CLINICAL LABORATORY AUTOMATION SYST--ETC(U).
MAY 77 R C BROOKS, I J CASEY, P W BLACKMON F49620-77-C-0025
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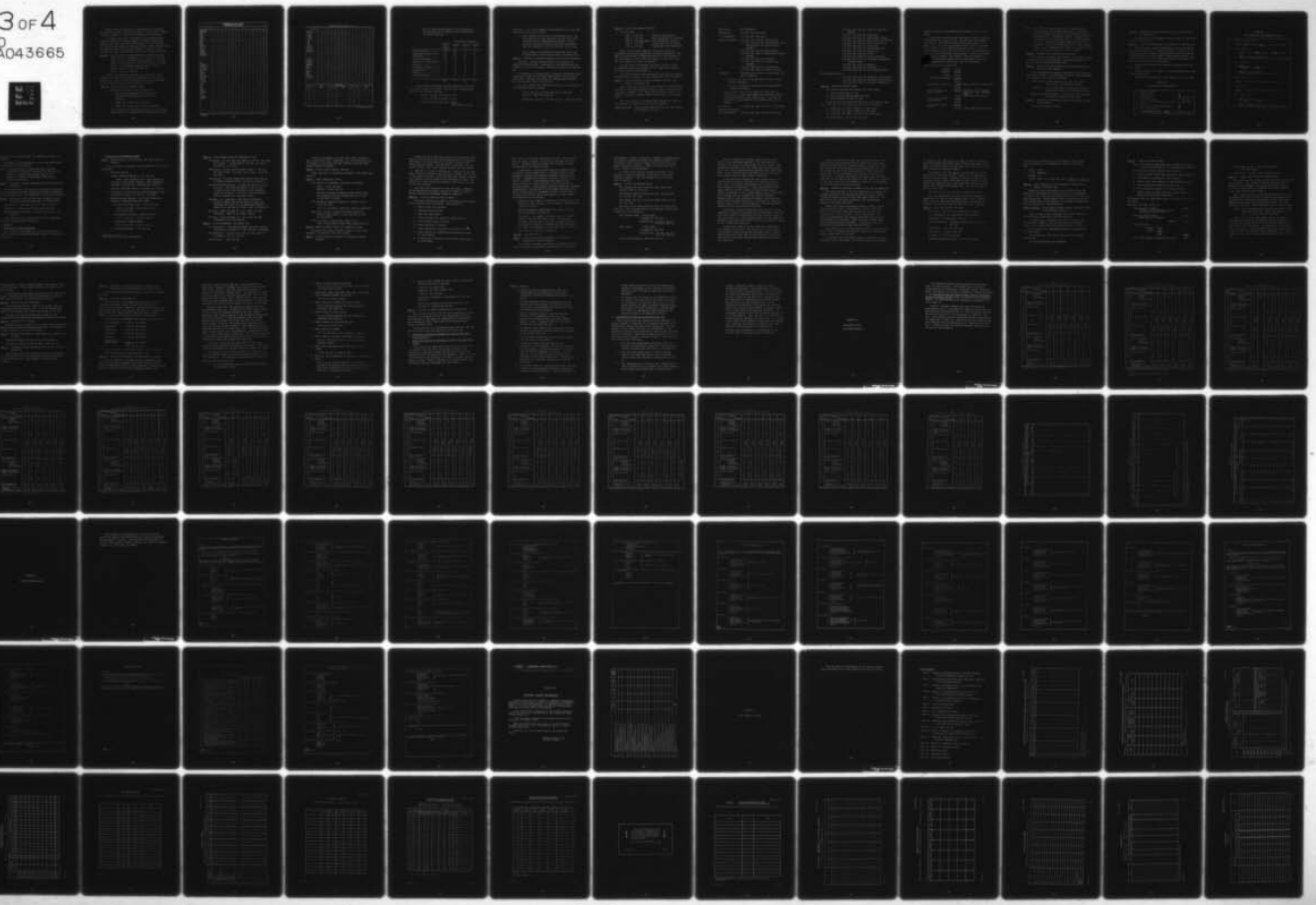

Mental flows are prepared for approximately 30 percent of the patients at a time cost of about 5 minutes each. These figures are based on informal discussions with physicians.

To estimate the total time spent on flow summaries per month, determine the average number of patients discharged/admitted per month; multiply that number by 15 (30) percent to find the total number of written (mental) flows, respectively. For written flows, multiply the number of flows by 13 min.; for mental flows, use 5 minutes as the time required for each.

Example: Average number of admissions per month using data from July 74 to December 74 = 714 per mo. 714 adm. per mo. X 0.15 written flows per adm. X 13 min. per flow ÷ 60 min. per hr. = 23.20 hr. per mo. 714 adm. per mo. X 0.30 mental flows per adm. X 5 min. ÷ 60 min. per hr. = 17.85 hr. per mo.
Total: 41.05 hr. per mo.

Written flow summaries are done in a variety of ways ranging from general narratives in progress notes to use of Form HW 8, a copy of which is included on the following page. Of the summaries observed, most were on Form HW 8.

Task 10. Filling Out Test Request Slips.

a. Slips are completed in one of three ways:

1. Addressographed/stamped with blanks for required information and filled out by patients;

2. Blank form filled out by patient;

3. Blank form filled out by clinic personnel.

From a sample of 100 outpatient slips, it was determined that the following percentages approximate, for

LABORATORY FLOW SHEET

DEPARTMENT OF INTERNAL MEDICINE

DATE →																
HEMATOCRIT																
HEMOGLOBIN																
WBC																
POLYS																
BANDS																
LYMPHS																
MONOS																
EOS																
BASOS																
RETICS																
ABNORMAL																
PLTS. × 10³																
ESR/CSR																
BLEEDING																
CLOTTING																
PROTHROMBIN																
FIBRINOGEN																
BUN																
CREATININE																
FASTING SUGAR																
P. C. SUGAR																
CHOLESTEROL																
BSP																
TOTAL BILI.																
DIRECT																
THYMOL TURB.																
TOTAL PROT.																
ALBUMIN																
ALK. P'TASE																
ACID P'TASE																
AMYLASE																
SGOT																
SGPT																
LDH																
SODIUM																
POTASSIUM																
CHLORIDES																
CO_2																
CALCIUM																
PHOSPHORUS																
URIC ACID																

HW FORM JUN 74 8

LABORATORY FLOW SHEET (Cont.)

DATE →															
URINE CULT.															
REACTION															
SP. G.															
ALBUMIN															
SUGAR															
ACETONE															
BILE															
RBC															
WBC															
CASTS															
24-HR. VOL.															
24-HR. PROT.															
24-HR. CREAT.															
CREAT.-CLEAR.															
LATEX TEST															
ASO TITER															
C-REACT. PROT.															
L. E. PREP															
HETEROPHILE															
VDRL															
GUAIAC															
WEIGHT															
INTAKE															
OUTPUT															
MAX. TEMP.															
TRANSFUSIONS															

SPECIAL TESTS

DATE	TEST	RESULTS	DATE	TEST	RESULTS	DATE	TEST	RESULTS

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each of these three methods of slip completion, the distribution of request slips originating in the various clinics:

	Percent of Total	Percentage Completed Method 1	Method 2	Method 3
Family Practice.....	26	20	6	0
Emergency/Primary Care....	24	24	0	0
Pediatrics.....	13	0	13	0
Internal Medicine.....	12	12	0	0
Obstetrics/ Gynecology....	9	6	3	0
Urology.....	5	0	0	5
Radiation Therapy.....	4	0	4	0
Orthopedics.....	3	0	3	0
Surgery.....	3	0	0	3
Cardio-Pulmonary.....	1	0	1	0
	100	62	30	8

Time studies showed that the time required to fill out a slip is 1.2 min., 1.75 min., and 0.62 min., respectively, for each of the three methods.

0.62 X 1.20 min. per slip = 0.744

0.30 X 1.75 min. per slip = 0.525

0.08 X 0.62 min. per slip = 0.050

1.319 min. per slip

Therefore, 1.32 X total number of outpatient slips is the time required to fill out all slips.

b. Time required to fill out an outpatient slip is the time required to find patient's card and print the information using addressograph machine. Using personal observation and good operator techniques, the time required to fill out one slip is 0.33 min.

c. Total number of inpatient and outpatient slips can be determined from the daily stack of Xeroxed slips.

Task 11. Completing Laboratory Request Slips Within Laboratory.

Generally, request slips that are not completed are returned to the patient. Occasionally, the receptionist completes a slip for the patient. This occurs about two times per day.

In Chemistry and Bacteriology, laboratory technicians sometimes have to make out new slips when several tests that are requested on the same slip cannot be accomplished together. This occurs about three times per day.

The time required for laboratory personnel to complete one slip averages about 2 minutes.

2 min. per slip X 5 slips per day X 20.99 days per mo. = 209.90 min. per mo.

209.90 min. per mo. ÷ 60 min. per hr. = 3.50 hr. per mo.

Task 12. Enter Test Results on Slips.

Time per test:

type a:	0.02 min.	(printed automatically)
type b:	0.05 min.	(from worksheets or log books)
type c:	Not applicable	(from instrument display)
type d:	0.05 min.	(transcribed from printout)
type e:	0.05 min.	(determined from observation)

Type e is for those tests for which the results are determined from visual observation or mental evaluation. The time for technicians to determine results is not included in the time shown for any of the five types of tests since this will not change as a result of AFCLAS.

For all practical purposes, the time to enter resutls on laboratory slips is the same for all tests except Hematology CBC (Complete Blood Count).

The list of tests, coded according to the way test results are entered on the report, is not reproduced in this appendix.

Task 13. Enter Headings on Test Worksheets, Workload Log Sheets, Log Books, etc.

Where this task exists, the time required is approximately the same as the time required to enter a line of data onto the log sheet, worksheet, etc. When counting lines of data (i.e., number of entries), headings should be counted as just another line.

The times required for various line entries are found in the listing for Tasks 14 and 15 in this appendix.

Tasks 14 and 15. Enter Patient Identification and Test Results on Worksheets, Logs, etc.

Hematology: Not Applicable

Coagulation: 0.63 min. per line entry

Stat Laboratory: 0.23 min. per line entry

Special Chemistry:
- 2.23 min. per line for Estriols Log
- 1.17 min. per line for Cerebrospinal Fluid (CSF) Protein and Serum Electrophoresis
- 0.63 min. per line for Immunoglobin
- 0.81 min. per line for Hemoglobin Electrophoresis
- 0.63 min. per line for Cortisols
- 0.77 min. per line for Alcohol, CO_2, Carotene
- 0.52 min. per line for Lipoproteins
- 0.58 min. per line for Stone Analysis

Chemistry: Pertains only to Task 15 since Task 14 is part of Task 22.

a. 0.05 min. per test to transcribe raw data to intermediate worksheet.

b. 0.03 min. per test to transcribe from intermediate to master worksheet.

Items a and b above do not apply for tests done on the HYCEL-17. Those test results are entered directly from the printout to the request slip. A listing of tests done on the HYCEL-17 is included later in this report.

Urinalysis: 0.75 min. per line for 24-hr. Urine Test

Bacteriology/Microbiology/Serology: 0.80 min. per line for Blood Cultures

0.63 min. per line for Report of Positive Results
0.56 min. per line for Infections
1.09 min. per line for Sperm Count (Stamp)
0.49 min. per line for Sperm Count line entries
0.74 min. per line for Urine Cultures Log
0.68 min. per line for Survey Log
0.71 min. per line for Tuberculosis Log
0.60 min. per line for Others Log
0.82 min. per line for Fungus
0.95 min. per line for Ova and Parasites
0.68 min. per line for Fluorescent Treponema Antibody (FTA)
0.45 min. per line for Rubella
0.40 min. per line for Pregnancy
0.55 min. per line for Viral Shipping Log.

Other Shipping Logs:

0.65 min. per line for Chemistry Shipping Log
0.65 min. per line for Urinalysis Shipping Log
0.80 min. per line for Serology Shipping Log

Task 16. Labeling Specimen Tubes.

The labeling process was divided into three steps:

a. Place masking tape on tube
b. Write patient identification on tube
c. Place numbered sticker on tube.

Times for each step were derived using a time study. The total time spent on each step was calculated as follows:

a. 0.050 min. per tube X number of tubes taped
b. 0.128 min. per tube X number of tubes used
c. 0.085 min. per tube X 65 percent of tubes used.

Weighted average = 0.233 min. per tube.

Activity frequency was determined by keeping track of tube usage.

A beginning inventory count was made of tubes on hand as of 0730 hours on 11 March 1975. New shipments were added to this figure. An ending inventory count was made as of 10 April 1975. The difference between these figures is assumed to be number of tubes labeled during this period of time. Other inventory counts were made during the intervening period to verify and substantiate the procedure. From the "Activity Issue/Turn-In Summary" (PCN N24011), the total number of boxes received during March 1975 was determined to be 164 boxes containing 100 tubes each (i.e., 16,400 tubes).

Tubes on hand on 11 March 1975:

	Labeled	3,126	
	Unlabeled	16,197	
	Total	19,323	
	Plus tubes received	+ 16,400	
		35,723	
	Minus tubes turned in	- 1,900	(tubes approaching expiration)
		33,823	
	Minus inventory on hand 10 April	- 16,176	(including 12,107 labeled tubes and 3,340 unlabeled tubes)
		17,647	tubes used during March
	Minus tubes labeled at beginning	- 3,126	
		14,521	
	Plus tubes labeled at end	+ 12,107	
		26,628	tubes labeled during March

Note: The number of tubes taped is not a representative figure because almost the entire stock of tubes on hand was labeled just prior to the Inspector General's visit and this is definitely unusual. Based on discussions with the laboratory staff a good average for an ending inventory of labeled tubes would be 3,500. Therefore, instead of 26,628 tubes as a count of those taped, a more representative figure for a normal situation total would be 14,521 + 3,500 = 18,021.

Task 17. Prepare (Sort) Slips for Ward Rounds.

This task is performed once per day. An average of about 30 slips are sorted each morning. The time required is 15 min. per day to order and divide slips.

Task 18. Supervisors' and Technicians' Review and Certification of Test Results.

The time expended in actual certification of results is very small; however, as results are copied or workload sheets are prepared, some review is performed.

Hematology: 0.25 min. per slip to look over, date, and initial (all Hematology slips).

Chemistry: 0.10 min. per slip to stamp with date and supervisor's name (only Chemistry slips).

Bacteriology/Microbiology: 0.20 min. per slip for about 15 percent of Bacteriology slips.

Task 19. Performing Statistical Analysis of Quality Control Sample Results.

See the discussion of Task 4.

Task 20. Performing Statistical Analysis of Patient Results by Population.

To the best of our knowledge, this task was not performed at all during period X.

Task 21. Perform Calculations or Conversions of Test Results.

The calculations under consideration in this hypothesis are listed in Table C-3. Items 1 through 8 in Table C-3 are accomplished using CREATE (a time-sharing computer system at Wright-Patterson Air Force Base). These tasks could be considered as part of Task 22 (Perform Computer Operations), but have been placed here for consistency.

Average time required for computer calculations is 1.50 min. each.

Items 9 through 15 in Table C-3 are done manually or with conversion wheels.

Average time required for these tasks is 0.75 min. each.

TABLE C-3

CALCULATIONS OF TEST RESULTS

1.	17-Hydroxy Steroids	Calculated by using the CREATE system
2.	17-Keto Steroids	
3.	Pregnancy Estriol	
4.	Urine Amylase	
5.	Creatinine Clearance	
6.	Intravenous Glucose Tolerance Test (IVGTT)	
7.	G6-PDH	
8.	Serum Protein Electrophoresis (SPELEC)	
9.	24-hr. Urine Protein	

$$\frac{\text{Total Volume (TV) in Ml.}}{100} \times \frac{\text{Mg.}}{100 \text{ Ml.}} = \text{Mg. Protein per 24 hr.}$$

TABLE C-3

CALCULATIONS OF TEST RESULTS (Cont.)

9. 24-hr. Urine Protein (Cont.)

$$\frac{\text{Total Volume (TV) in Ml.}}{100} \times \frac{\text{Mg.}}{\text{100 Ml.}} = \text{Mg. Protein per 24 hr.}$$

10. Xylose Absorption

a. $\frac{\text{Mg.}}{\text{100 Ml.}}$ of test - $\frac{\text{Mg.}}{\text{100 Ml.}}$ of control = $\frac{\text{Mg.}}{\text{100 Ml.}}$ of Xylose

b. $\frac{\frac{\text{Mg.}}{\text{100 Ml.}} \text{ of Xylose X TV of test (L.)}}{100} = \text{Gm. of Xylose excreted}$

11. Urine Phosphorous

a. $\frac{\frac{\text{Mg.}}{\text{100 Ml.}} \text{ of } PO_4}{1000} = \frac{\text{Gm.}}{\text{100 Ml.}} PO_4$

b. $\frac{\frac{\text{Gm.}}{\text{100 Ml.}} \text{ of } PO_4 \text{ X TV (100s)}}{100} = \text{Gm. } PO_4 \text{ per 24 hr.}$

12. Urine Uric Acid

$\frac{\text{Mg.}}{\text{100 Ml.}}$ of Uric Acid X TV = Mg. of Uric Acid per 24 hr.

13. Urine Calcium

$\frac{\text{Mg.}}{\text{100 Ml.}}$ of Calcium X TV = Mg. of Calcium per 24 hr.

14. 24-hr. Urine Glucose

a. $\frac{\frac{\text{Mg.}}{\text{100 Ml.}} \text{ of Glucose}}{1000} = \frac{\text{Gm.}}{\text{100 Ml.}}$ of Glucose

b. $\frac{\frac{\text{Gm.}}{\text{100 Ml.}} \text{ of Glucose X TV (100s)}}{100} = \text{Gm. of Glucose per 24 hr.}$

TABLE C-3

CALCULATIONS OF TEST RESULTS (Cont.)

15.	Urine Creatinine AA (Raw Score) Creatinine X Dilution = $\frac{\text{Mg.}}{\text{100 Ml.}}$ of Creatinine
16.	Other The *Stat* Laboratory used a conversion wheel for several other tests.

Task 22. Perform Computer Operations (CREATE).

Input slips:	0.39 min. per slip
Worksheets:	0.05 min. per test type (average)
Master Worksheet:	0.11 min. per patient (average)
Daily Totals:	2.41 min. per day
Monthly Totals:	5.53 min. per mo.

All slips are entered into the system for Chemistry and Special Chemistry. Worksheets are run for all tests not performed by the HYCEL-17. Master worksheets are run for all patients.

Task 23. Duration of *Stat* Calls.

Time required is 2.5 min. per call.

Average number of calls per day is estimated to be 20 for entire laboratory based on personal observation.

Task 24. Tracking Down Errors in Test Results by Laboratory Officers.

Very little time was expended performing this task. Most of the time spent tracking down errors is done by laboratory

technicians or section NCOICs. The estimate includes all personnel.

Estimate of time requirement is 5 min. per week (based on observation and interview).

Note: The time laboratory technicians spent tracking problems was included in the time for copying test results. Problems were tracked down, but it seemed to be done by technicians rather than by laboratory officers.

Task 25. Processing Inquiry Telephone Calls to the Clinical Laboratory

The average time of 2.05 min. for an inquiry telephone call was computed from data collected by direct observation of the reception area. See Chapter II, "Statistical Studies."

Task 26. Retrieval of Data on the Time to Answer Inquiry Telephone Calls and Completing the Return Calls.

Hematology: 3 calls per wk. at 15 min. per call.

Chemistry: 4 calls per wk. at 15 min. per call.

Bacteriology/Microbiology: 6 calls per wk. at 3 min. per call.

Other sections do not receive calls to be researched frequently enough to merit attention.

B. Period Y

1. Description of Data Collection

Data collection procedures for period Y were substantially the same as those described for period X in Section A, Subsection 1.

2. Results of Time Studies by Task*

Task 1. Administrative, CAP, Workload, and Other Types of Reports.

Data are based on estimates from the NCOIC of the Clinical Laboratory.

a. Workload Reports.

Monthly Workload Reports = 1 hr. per mo.

Most of the information for these reports is retained in the system; however, some adjustments are made to correct for standards and surveys.

Quarterly Workload Reports = one-half hr. per qtr.

b. CAP Reports require slightly less preparation than in period X; about 2 hr. per mo. is needed.

c. Bacteriological Reports - time requirements are basically unchanged except as noted:

- Positive Beta Strep List - 5 min. per day

  0.08 hr. per day X 20.99 days per mo. = 1.68 hr. per mo.

- Environmental Surveys - same as before.

  0.75 hr. per wk. = 3.26 hr. per mo.

- Communicable Disease Report -

  0.75 hr. per wk. = 3.26 hr. per mo.

- Antibiogram Report - 5 hr. per mo.

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* See Table C-1 for task descriptions.

Task 2. Filing Request Slips in Laboratory Files

Urinalysis: 6.1 min. per 100 cards or 0.06 min. per card. For period Y - 2,366 cards X 0.06 min. per card = 141.96 min. = 2.37 hr.

Hematology: 1.0 min. per 20 cards (slips) = 0.05 min. per card (slip). 0.25 min. per 5 slips = 0.05 min. per slip.

Coagulation: To place rubber band around cards and put in drawer requires 20 min. per month in period Y.

Microbiology/Bacteriology: 6 times per day at 0.5 min. per card. Cards are maintained 1 week in rack on desk top and then discarded; only Urinalysis slips are retained. 0.25 min. per day additional time is required for Urinalysis slips.

Chemistry, *Stat* Laboratory, and Special Chemistry: To place rubber band around cards as tests are completed and store (in a disorganized fashion) takes 2 min. per day or 20 min. total for period Y.

Serology: Cards are kept for 1 or 2 days and then discarded. There is no formal filing.

Cytology: Cards are kept for 1 or 2 days and then discarded if data are correct.

Task 3. Filing Worksheets, Log Sheets, etc.

Stat Laboratory: The same worksheets and same process are used as in period X; 1 min. per day is required.

Auto-Chemistry: requires the filing of four HYCEL-17 worksheets at 1 min. per day.

Bacteriology: 1 min. per day.

Filing of worksheets is a very minor task, consuming very little total time. Generally, the filing process is one of stacking up the forms and then throwing them away after several weeks have passed.

Task 4. Filing Quality Control Reports.

There have been no significant changes in this task since period X.

Task 5. Other Laboratory Filing.

File Report of Procedures (new task with AFCLAS)

Daily - 2 min. per day
Monthly - 2 min. per mo.

The task consists of obtaining the reports from the computer room and stacking them on a shelf in the NCOIC's office.

File Discharge Cumulative Report in computer room - 5 min. per day.

(This is included in tasks for computer operators.)

Beta Strep Listing - Computer-produced report of positive Beta Streps - 1 min. per day to file and distribute.

There has been no significant change in the other miscellaneous filing tasks since period X.

Task 6. Remove Outdated Items from Laboratory Files.

No significant amount of time is spent on this task; Therefore, for period Y the time is zero.

Task 7. Filing Laboratory Results in Outpatient Medical Records.

Reports are delivered each morning at approximately 0700 hours or 0730 hours by the chief pathologist or his secretary. The reports are then ordered by the last 4 digits of the Social Security Number. The day shift places them into the record and the night shift staples the data into the record.

Changes as a result of AFCLAS are: deletion of the step where the last 4 digits of Social Security number were written on the result slip with a felt pen; OMR sorts Discharge Cumulative Reports and files these as the opportunity occurs. The process for filing Cumulative Reports is the same as that for filing other reports.

The total time required is 1 min. per page. Frequency can be determined from daily listing of reports by distribution location and Discharge Cumulative Reports.

Task 8A. Filing of Results Slips on Wards.

This task comprises the time to file patient test results in the inpatient record on wards. The process is:

1. Remove edges from reports;
2. Separate second copies;
3. Tear each page apart;
4. Staple together all sheets for same patient;
5. Place second copies in trash;
6. Place originals in record;
7. Place reports for preoperative patients in trash;
8. Place reports for discharged/transferred patients in "out" basket;
9. If record for a patient is not found, place report in file basket.

Time to file is 0.23 min. per patient record. Total process time for steps 1 through 5 is 0.32 min. per page of daily report. Frequency should be taken from the daily listing of distribution of reports (pages).

In addition to routine Daily Cumulative Reports, about 10 percent of the records have *stat* reports filed in them and about 5 percent have special cumulative reports filed in them. (Preparation of special cumulative reports is included in Task 9.) These estimates are based on the records that were reviewed during the ward search and in clinical records. Since patient registry numbers are assigned consecutively, subtracting the first number assigned on 15 March from the last one assigned on 9 April would result in a figure that should closely approximate the total number of admissions for the period.

Estimated total number of admissions for period Y is 787. (Using the same procedure, total number of admissions for period X is 744.)

The total number of admissions for 1 year is 9,739, for an average of 812 per mo.

In period Y, the number of records with *stat* reports filed in them is 787 X 0.10 = 78.7 ≃ 79 reports X 0.23 min. to file each = 18.17 min.; adding 0.50 min. per report to obtain *stat* reports and get them ready to file, or 79 reports X 0.5 min. per report = 39.5 min.

The total is 57.67 min. in period Y.

Task 8B. See Table III-2.

Task 9. Prepare and File Flow Summaries or Cumulative Summaries of Patient Results.

The number of manually prepared flow summaries and the time to prepare them should be approximately equal to the

corresponding figures in period X. Although it seems unusual, the number of manually prepared flow summaries observed in the records during period Y seemed to be greater than the number observed in period X. There is no hard data available to support this impression.

The time to file special cumulative reports in the patient's records is the same as the time to file Daily Cumulative Reports. The time required is 0.32 min. per page of reports.

Task 10. Filling Out Request Slips.

The average time for filling out high volume test request cards is 0.708 min.

The average time for filling out test request cards is 0.71 min. per card.

The average time for filling out admit cards is 0.93 min. per card.

Frequency can be taken from the count of total cards received. (The procedure used in the analysis is described in Section E of Appendix B.)

Test request cards: 15,219 cards

X 0.71 min. per card

10,805.49 min. ÷ 60 min. per hr. = 180.09 hr. per mo.

Admit cards: 8,937 cards

X 0.93 min. per card

8,311.41 min. ÷ 60 min. per hr. = 138.52 hr. per mo.

Total time on cards is 318.61 hr. per mo.

With the exception of Family Practice Clinic (FPC), which will be discussed separately, the same process is followed for making out request cards in all clinics. The requesting physicians mark the tests that they are requesting or tell clinic administrative personnel what tests they want. Clinic administrative personnel fill out the rest of the information and an admit card if required.

In FPC physicians prepare the test request portion of Form HW 168; the patient carries it to the waiting area where clinic administrative personnel or the patient complete patient ID information. Clinic administrative personnel use Form HW 168 to make out test request cards. Another difference in FPC is that packets of cards and information sheets are put together for routine physicals. Request cards in these packets are marked in advance with tests to be requested and clinic ID information. When the patient comes in for a routine physical, only the patient ID information must be marked on the cards.

One problem created by the use of Form HW 168 is that occasionally patients go straight to the laboratory with only this form instead of stopping at the clinic waiting area to have cards made out. When patients show up at the laboratory reception area with Form HW 168, they are instructed to return to FPC to have cards made out.

Patients also show up in the laboratory occasionally with packets for physicals that have only one card marked with patient information and the remainder blank. Usually these patients are sent back to the requesting clinic, but occasionally laboratory receptionists complete the cards in the laboratory.

Family Practice Clinic also has a listing of most of the tests done by the laboratory and an indication of the corresponding AFCLAS form that should be used to request the tests. The listing is six pages long and was prepared by one of the FPC nurses who was at the time a patient at MCWP with some extra time. To our knowledge, this listing is the only one of its kind. It seems that each clinic should have something like this to cut down on the number of times tests are requested on the wrong card and on the number of calls to the laboratory to find out which form should be used.

Task 11. Completing Laboratory Request Slips Within Laboratory.

The usual practice is for the receptionist to return the incomplete cards to the patient and instruct him to return to the originating clinic to have the cards filled out. If the card is only partially incomplete, the receptionist makes the necessary additions.

Almost all cards are routinely marked a second time to darken the data fields. This results, in part, from the Mark Document Reader (MDR) sensitivity and, in part, from receptionists' habit patterns. With encouragement, one of the receptionists tried running the cards first to see if they needed to be remarked. About 75 percent of the cards were acceptable without remarking. In spite of this, the receptionist continued to mark the cards twice.

The average time to recode cards is 0.98 min. per patient. Note: Time to complete this task is included in receptionist duties rather than in this task.

An accurate count of cards filled out completely in the laboratory is not available. In several sections, Urinalysis

for example, new cards have to be made out when the computer goes down because the results are written on the card. With these extraneous marks, the old cards cannot be read into the MDR to obtain an accession number.

An estimate as to the number of cards made out in the laboratory is 350 cards per mo. Almost all of these cards are test request cards. Hematology Diffusion cards are not included in this figure since they are more similar to worksheets than anything else. The figure does include Cytology cards. The average time to make out a test request card is 0.71 min. per card.

350 cards X 0.71 min. per card = 248.5 min. per mo.

Also for Hematology, 0.45 min. per CBC is required to prepare the old type of test request form. Note: Shortly after period Y, personnel started using one of the extra labels on the Coulter S card so this time is not included.

Task 12. Enter Test Results on Slips.

Hematology: 0.50 min. per differential request

Stat Laboratory: Not applicable (use worksheet)

Chemistry: Not applicable (online)

Special Chemistry: Estimated average time is 0.60 min. per card

Coagulation: 0.28 min. per card

Urinalysis: 0.54 min. per card

Cytology: 0.37 min. per card

Microbiology/Bacteriology: 1.03 min. per card

As a basis for calculation, use the number of test request cards, excluding *Stat* and Chemistry, times 0.55 min. per card.

	18,347	cards
-	2,332	Chemistry
-	3,466	*Stat*

12,549 cards X 0.55 min. per card = 6,901 min. ÷ 60 min. per hr. = 115.03 hr.

Task 13. Enter Headings on Test Worksheets, Workload Log Sheets, Log Books, etc.

Except for the Urine Culture Log in Microbiology, and Chemistry's worksheets generated by CREATE, all worksheets, log sheets, etc. that were maintained during period X are still being maintained. There appears to be no significant difference between period X and period Y with respect to this task, with the exception of Auto-Chemistry.

Tasks 14 and 15. Enter Patient Identification and Test Results on Worksheets, Logs, etc.

There is very little difference from period X except in Auto-Chemistry, Hematology, and Microbiology.

In Hematology, a worksheet-type form is made out for differentials; however, this was considered as recording results onto request cards and reported as part of Task 12.

In Auto-Chemistry, worksheets generated by CREATE are no longer used.

In Microbiology, the Urine Culture Log is no longer maintained.

All other worksheets are unchanged.

Task 16. Labeling Specimen Tubes.

Note: The procedure described here includes only those activities that pertain to involvement with AFCLAS.

Drawing room personnel perform the following:

1. Receive request cards from laboratory receptionist(s);
2. Draw blood as indicated by test request;
3. Detach labels from backing to expose adhesive side;
4. Affix appropriate label(s) to test tube;
5. Affix remaining labels to test request card;
6. Deliver tubes of blood with test request card to appropriate laboratory department.

The average time for completing steps 3, 4, and 5 is 0.50 min. per tube.

Specimen Tube Usage (Task 16)

Tubes on hand 30 March: (In store room, collection trays, Chemistry, Drawing Room)			20,549
Tubes on hand 12 April: (same areas as 30 March)			- 16,766
		Change =	3,783
Tubes received:			
30 March	4,000		
6 April	900		
	4,900	+	4,900
Total used between 30 March and 12 April:			8,683

667.9 tubes per day X 26 days in period Y =
17,366 tubes used.

8,683 tubes ÷ 13 days = 667.9 tubes per day.

Task 17. Prepare (Sort) Slips for Ward Rounds.

The procedures for setting up morning rounds have changed significantly. The process of actually drawing the blood appears to be unchanged. The same problems that existed in period X with respect to locating the correct patient (i.e., ward and bed) still exist.

Time required to set up for morning rounds is 12.5 min. to prepare load list; 10 min. to arrange and separate card assignments to laboratory technicians; 25 min. to process specimens upon return from collection rounds. Each item occurs once per day. Total time spent is 47.5 min. per day.

Note: To be consistent with period X, we include only the first two steps. Total time spent is 12.5 min. + 10 min. = 22.5 min. per day.

Other trips to the wards during the day to take *stat* specimens are unchanged from period X except in volume. A list was kept during period Y of trips to the wards but it was inadvertently destroyed. Our estimate is 15 trips per day are required. The only relationship this could have to AFCLAS is that more tests are being requested *stat*. This seems to be true but we have not compiled the data to verify it.

Task 18. Supervisors' and Technicians' Review and Certification of Test Results.

In theory, supervisors are supposed to verify the test results; however, in practice, test verification occurs simultaneously with test entry. One exception to this is Hematology, where each entry from the online Coulter S is verified against hard-copy results by a supervisor or other capable person. In Auto-Chemistry, tests are also verified; however, it is done by the laboratory technicians who know the HYCEL-17 system.

Time required is 0.17 min. per patient for Hematology, and 0.29 min. per HYCEL-17 request card.

Tasks 19 and 20. Performing Statistical Analysis of

(19) Quality Control Sample Results; and
(20) Patient Results by Population.

During the entire time that we were in the laboratory, we did not observe any analysis being done, outside of that done by AFCLAS. Normals are calculated by the system based on the age, sex, and race data on the admit card. Because of inaccuracies on a significant number of admit cards, the normality or abnormality of a test result is questionable.

Time required is approximately zero.

Task 21. Perform Calculations or Conversions of Test Results.

AFCLAS has apparently had no impact on this task.

Until the removal of the CREATE terminal from the laboratory, it was used for calculations the same as in period X. Near the end of period Y, the terminal was removed to make better use of the space it occupied. From that time on, calculations were done either by hand or laboratory

personnel went to another terminal within the hospital to do the calculations. In any event, AFCLAS is not used for the calculations.

Conversions are still made, as required, with tables and wheels. The Technicon Stat Ion has eliminated the need for some conversions but it is not online with AFCLAS.

Task 22. Perform Computer Operations.

As discussed previously, CREATE is no longer used for worksheets, workload reports, etc. It is now occasionally used for calculations, but that is the extent of its use.

Changes as a result of AFCLAS are limited to the elimination of Auto-Chemistry Worksheets and Workload Reports.

Task 23. Duration of *Stat* Calls.

Laboratory policy is that all *stat* reports be called back. Seventy-five percent or more are called back. Time required is approximately 0.75 min. for each call.

Task 24. Tracking Down Errors in Test Results by Laboratory Officers.

Estimated average time is 5 min. per occurrence.

Estimated frequency is two per day, 5 days per wk.

Task 25. Processing Inquiry Telephone Calls to the Clinical Laboratory.

The average time of 2.10 min. for an inquiry telephone call was computed from data collected by direct observation of the reception area. (See Chapter II, "Statistical Studies.")

Task 26. Retrieval of Data on the Time to Answer Inquiry Telephone Calls and Completing the Return Calls.

This task was eliminated by AFCLAS. Total time required is zero.

Task 27. Unfinished Work Reports.

During period Y, unfinished work reports were run at irregular intervals, usually two per section per week. Shortly after the end of period Y, the process was formalized and reports were run each day for each section. This reduced the size of each report and the time required to locate, enter, or cancel test results and clear up the reports.

During period Y, estimated time required was as follows:

Stat Laboratory	-	1.00 hr. per report
Coagulation	-	0.75 hr. per report
Urinalysis	-	0.50 hr. per report
Hematology	-	2.00 hr. per report
Chemistry	-	1.50 hr. per report
Microbiology/ Bacteriology	-	2.00 hr. per report
		7.75 hr. per report

7.75 hr. per report X 2 reports per week = 15.5 hr. per wk.

Total time required in period Y was 62 hr.

Task 28. Addition of Cytology to AFCLAS Reporting System.

The time required to process Cytology specimens using AFCLAS is basically the same as the time required prior to system implementation plus all time required to support AFCLAS. Old test request forms are still prepared; however, now

mark-sense cards are also made out. The problems that impact other laboratory sections with respect to the system also impact Cytology. The most significant problem is created by improperly prepared cards. The same general categories of persons fill out Cytology cards that fill out other laboratory test request cards. OB/GYN clinic, FPC, and the Obstetrics ward generate most of the specimens. No data were collected for Cytology for the period X portion of the study.

Workload comes into the laboratory between 1530 hours and 1600 hours each day. Frequently, the night shift personnel do not get the requests processed into the system; therefore, work actually begins on the specimens between 0600 hours and 0700 hours. After the request cards have been entered into the system, the slides are made out and all items (labels, old form, mark-sense card, specimens, etc.) for each test are grouped together. Test results are determined and entered on the cards and forms. The cards are then used to enter results into the system via a Cathode-Ray Tube (CRT). This usually begins about noon. The following morning, an unfinished work report is run and errors from the previous afternoon's results are entered and corrected.

The study of Cytology was restricted to only those items that are directly involved with the system. This time should be interpreted as the net change as a result of AFCLAS.

The frequency for Cytology procedures for period Y was from the "Monthly Report of Patients" as described in Section C of Appendix B. The frequency is approximately 900 per mo.

Cytology Task Times (Task 28)

1. Fill out AFCLAS test request cards (time included in receptionist duties).

2. Obtain accession number and label.

   0.06 min. per card to print label (time included in receptionist duties).

3. Match card, label, old form (Form 541), and slide; write accession number on old form.

   0.60 min. per test request.

4. Enter patient ID information into log book.

   This is omitted because the time required is unchanged from period X.

5. Screen slide for test results.

   This is omitted because the time required is unchanged from period X.

6. Record results on old form and card.

   0.50 min. per test entry.

7. Enter results on cards.

   0.37 min. per card (time included in item 6).

8. Enter results from cards to computer via CRT.

   0.52 min. per result entry; i.e., per patient accession number.

9. Check unfinished work report and correct input errors.

   30 min. per day, 5 days per week.

10. Admit and verify admission of patients on individual basis.

    0.97 min. per patient admitted. An estimated average of 15 patients per day requires this task. Total time required is 14.55 min. per day (time included in receptionist duties).

11. Make out test request and admit cards for specimens received from other hospitals.

0.98 min. per admit card
0.68 min. per test request card

1.66 min. per specimen

An estimated average of 10 specimens per day are received.

Total time required is 16.60 min. per day (time included in receptionist duties).

Task 29. Printing of MAMS-R Information for AFCLAS Use.

The long way requires 1.00 min. per transaction to print. The short way requires 0.25 min. per transaction to print. The frequency is the number of transactions from Admissions and Dispositions (A&D) sheets that would change patient status in AFCLAS files.

During period Y, all transactions were done the long way. By 10 May 1976, they were being done the short way.

C. Additional Information Gathered and Observations Made During Period Y.

1. Steps/Time Required to Process a Patient Into the AFCLAS System.

Listed below are seven steps that indicate the activity of a patient from the point the patient arrives at the laboratory receptionist's desk through the collection and dissemination of the patient's test specimen. Steps 1 through 4 indicate the tasks required to process a patient into the computer system. Steps 5 through 7 are tasks required after the patient has been processed into the system.

Steps 1 through 7:

1. Patient arrives at receptionist's desk and is acknowledged by the laboratory receptionist (laboratory receptionist hereinafter referred to as LR).

2. Computer specimen card(s) are received from the patient and the LR visually verifies the card(s) for accuracy, completeness and legibility of the information contained thereon.

3. Due to lightness of pencil code marks on the card(s), the LR recodes/remarks card(s) by going over previously made marks with a darker medium. (Note: If pencil marks are too light, the MDR will not read the card.)

4. LR passes card(s) through MDR to be read into the system; this causes a specimen label to be printed on the TermiNet device.

   At this point, the patient has now been processed into the system as an "admit."

5. LR retrieves label from the TermiNet and attaches it to the specimen card and secures both to the specimen. An exception occurs if a patient requires a blood specimen to be drawn. In that case, the LR will hand-carry the printed label with card to the blood drawing room. Drawing room personnel will then call the patient in for the blood draw.

6. If patient brought in appropriate specimen, then same is taken to the appropriate laboratory department personnel for their activity. (Note: Specimens are

either hand-carried by the LR to the appropriate laboratory department or the laboratory department personnel will visit the LR area and pick up the specimens.)

7. If patient has not brought in the appropriate specimen sample, then the LR gives the label and card(s) to the patient and instructs patient to go to the proper facility to obtain necessary specimen sample. The patient is further instructed to attach label and card(s) to the specimen sample obtained and leave all items in an indicated location.

2. Observations Pertaining to the Reception Area.

This is one of the key locations in the laboratory for several reasons. Primarily, it is important because it is all that many people ever see of the laboratory. For this reason, it must appear efficient and professional. This appearance could be better attained by clearing away the major source of confusion, namely the telephone-answering function. This task could be moved to another location. There are several alternatives available:

1. Move the telephone-answering function, CRT, and printer to Microbiology, along with rerouting Microbiology specimens past front desk to this section;

2. Move the chief pathologist's office to another location and make that area an inquiry/response center manned with laboratory technicians and CRTs; or

3. Move telephones to typing area near Histopathology. From our observation, it appears that these personnel could absorb the workload and it would provide a

central, independent section that would reduce unnecessary confusion. The alternative we recommend is the relocation to Microbiology. This would reduce the items and specimens that clutter the front desk by over a third; at the same time, this would free the remaining two receptionists to process patients who are waiting in the reception area. As an additional consideration, the possibility currently exists for a spillage with respect to improper handling of some types of Microbiology specimens. The accidental opening of an active TB sputem specimen is an extreme example. Also, the useful life of some of the Microbiology specimens is quite short (e.g., sperm counts) and we have observed on more than one occasion that a specimen was allowed to remain at the front desk past the expiration of its usefulness.

Although this alternative is recommended, we feel that the other two choices are also workable.

APPENDIX D

STATISTICAL DATA

FROM QUESTIONNAIRES

This appendix presents the statistical data obtained from the questionnaires. The methods used to score the questionnaires for physicians, registered nurses, laboratory staff, and patients are given in Appendix C, "Survey Schedules", of the Evaluation Plan for the Air Force Clinical Laboratory Automation System (AFCLAS) [Ref. 1] and will not be repeated herein. All questionnaires are reproduced in Appendix E to this Volume II.

Table D-1 presents summary data from the Physician Questionnaire Part 1, and Table D-2 presents similar data for the Physician Questionnaire Part 2. The information given in Tables VI-9 and VI-10 is not reproduced in Tables D-1 and D-2. Data obtained from the Registered Nursing Questionnaire is summarized in Table D-3. Tables D-4 and D-5 summarize the data gathered from the Laboratory Staff Questionnaire Parts 1 and 2. Finally, Table D-6 presents the data collected with the Patient Questionnaire.

TABLE D-1

STATISTICAL DATA FROM PHYSICIAN'S QUESTIONNAIRE PART 1

Data Coll. Pd.	Item \ Question Number	1	2	3	4	5	6
X	Response 1 Very Satisfied	4	3	4	4	2	1
X	" 2 Satisfied	5	9	12	4	7	7
X	" 3 Neutral	62	34	33	26	49	37
X	" 4 Dissatisfied	17	32	34	36	26	34
X	" 5 Very Dissatisfied	1	11	6	19	5	10
X	" 6 -	-	-	-	-	-	-
X	Number of Valid Responses	89	89	89	89	89	89
X	Number of "No Opinion" *	-	-	-	-	-	-
X	Number of "Blank Responses"	0	0	0	0	0	0
X	Percent Responding 1	4	3	4	4	2	1
X	" " 2	6	10	14	5	8	8
X	" " 3	70	39	37	29	55	42
X	" " 4	19	36	38	41	29	38
X	" " 5	1	12	7	21	6	11
X	" " 6	-	-	-	-	-	-
X	σ - Distance from Mean 1	-2.16	-2.28	-2.16	-2.16	-2.44	-2.70
X	" " " " 2	-1.49	-1.43	-1.26	-1.52	-1.59	-1.70
X	" " " " 3	-.149	-.482	-.364	-.75	-.355	-.566
X	" " " " 4	1.33	.55	.69	.225	.87	.55
X	" " " " 5	2.70	1.67	1.92	1.37	1.99	1.71
X	" " " " 6	-	-	-	-	-	-
X	Standard Score(SS) 1	28.4	27.2	28.4	28.4	25.6	23.0
X	" " 2	35.1	35.7	37.4	34.8	34.1	33.0
X	" " 3	48.5	45.2	46.4	42.5	46.5	44.3
X	" " 4	63.3	55.5	56.9	52.3	58.7	55.5
X	" " 5	77.0	66.7	69.2	63.7	69.9	67.1
X	" " 6	-	-	-	-	-	-
X	Sum of (Frequency × SS)	4449.2	4449.4	4443.4	4450.9	4444.1	4451.1
X	Mean Standard Score	49.99	49.99	49.93	50.01	49.93	50.01
Y	Response 1 Very Satisfied	26	1	0	0	0	0
Y	" 2 Satisfied	27	3	7	5	4	11
Y	" 3 Neutral	41	30	24	29	39	38
Y	" 4 Dissatisfied	12	33	50	39	41	38
Y	" 5 Very Dissatisfied	6	44	31	39	27	23
Y	" 6 -	-	-	-	-	-	-
Y	Number of Valid Responses	112	111	112	112	111	110
Y	Number of "No Opinion" *	-	-	-	-	-	-
Y	Number of "Blank Responses"	0	1	0	0	1	2
Y	Percent Responding 1	23	1	0	0	0	0
Y	" " 2	24	3	6	4	4	10
Y	" " 3	37	27	21	26	35	35
Y	" " 4	11	30	45	35	37	35
Y	" " 5	5	40	28	35	24	21
Y	" " 6	-	-	-	-	-	-
Y	Sum of (Frequency × SS)	4896.2	6256.6	6365.6	5930.5	6243.9	5698.7
Y	Mean Standard Score	43.72	56.37	56.84	52.95	56.25	51.81
	Estimate of Std. Deviat.	13.52	9.81	9.49	9.17	9.98	10.46
	t Statistic	-51.98	72.07	81.55	35.91	70.30	18.86
	Significance Level of Change	0.001	0.001	0.001	0.001	0.001	0.001

* Response "No Opinion" is not used in Physician's Questionnaire Part 1.

TABLE D-1 (cont.)

STATISTICAL DATA FROM PHYSICIAN'S QUESTIONNAIRE PART 1

Data Coll. Pd.	Question Number / Item	7	8	9	10†	11†	12†
X	Response 1 Very Satisfied	2	0	2	17	28	29
X	" 2 Satisfied	11	7	10	33	36	52
X	" 3 Neutral	26	14	26	28	15	5
X	" 4 Dissatisfied	27	23	38	6	4	1
X	" 5 Very Dissatisfied	22	44	12	1	1	0
X	" 6 -	-	-	-	3	1	1
X	Number of Valid Responses	88	88	88	88	85	88
X	Number of "No Opinion" *	-	-	-	-	-	-
X	Number of "Blank Responses"	1	1	1	1	4	1
X	Percent Responding 1	2	0	2	19	33	33
X	" " 2	12	8	11	38	42	59
X	" " 3	30	16	30	32	18	6
X	" " 4	31	26	43	7	5	1
X	" " 5	25	50	14	1	1	0
X	" " 6	-	-	-	3	1	1
X	σ - Distance from Mean 1	-2.44	-3.0	-2.44	-1.43	-1.10	-1.10
X	" " " " 2	-1.45	-1.86	-1.48	-.318	.101	.364
X	" " " " 3	-.57	-1.01	-.60	.64	1.02	1.67
X	" " " " 4	.243	-.34	.396	1.46	1.72	2.18
X	" " " " 5	1.27	.80	1.59	1.81	2.18	2.33
X	" " " " 6	-	-	-	2.28	2.70	2.70
X	Standard Score (SS) 1	25.6	20.0	25.6	35.7	39.0	39.0
X	" " 2	35.5	31.4	35.2	46.8	51.0	53.6
X	" " 3	44.3	39.9	44.0	56.4	60.2	66.7
X	" " 4	52.4	46.6	54.0	64.6	67.2	71.8
X	" " 5	62.7	58.0	65.9	68.1	71.8	73.3
X	" " 6	-	-	-	72.8	77.0	77.0
X	Sum of (Frequency × SS)	4387.7	4202.2	4390.0	4404.6	4248.6	4400.5
X	Mean Standard Score	49.86	50.03	49.89	50.05	49.98	50.01
Y	Response 1 Very Satisfied	0	0	0	26	28	36
Y	" 2 Satisfied	6	10	7	40	51	39
Y	" 3 Neutral	35	24	27	15	12	19
Y	" 4 Dissatisfied	44	38	40	11	7	7
Y	" 5 Very Dissatisfied	27	40	37	6	5	3
Y	" 6 -	-	-	-	13	3	6
Y	Number of Valid Responses	112	112	111	111	106	110
Y	Number of "No Opinion" *	-	-	-	-	-	-
Y	Number of "Blank Responses"	0	0	1	1	6	2
Y	Percent Responding 1	0	0	0	23	26	33
Y	" " 2	5	9	6	36	48	35
Y	" " 3	31	21	24	14	11	17
Y	" " 4	39	34	36	10	7	6
Y	" " 5	24	36	33	5	5	3
Y	" " 6	-	-	-	12	3	5
Y	Sum of (Frequency × SS)	5762.0	5362.4	6032.7	5711.8	5475.8	5946.2
Y	Mean Standard Score	51.45	47.88	54.35	51.46	51.66	54.06
	Estimate of Std. Deviat.	7.81	8.70	9.72	12.49	10.25	12.74
	t Statistic	22.74	-27.63	50.94	12.48	17.32	34.99
	Significance Level of Change	0.001	0.001	0.001	0.001	0.001	0.001

* Response "No Opinion" is not used in Physician's Questionnaire Part 1.

† Questions 10,11,12 are factual with six possible responses. They are not included in computation of satisfaction reported in Table VI-9.

TABLE D-1 (cont.)

STATISTICAL DATA FROM PHYSICIAN'S QUESTIONNAIRE PART 1

Data Coll. Pd.	Item \ Question Number	13	14[†]	15	16	17	18	19
X	Response 1 Very Satisfied	5	Yes	4	2	1	4	0
X	" 2 Satisfied	7	No	20	16	10	8	7
X	" 3 Neutral	49	Quest.	24	35	41	36	51
X	" 4 Dissatisfied	19		28	19	20	26	25
X	" 5 Very Dissatisfied	5		9	14	14	15	5
X	" 6 -	-		-	-	-	-	-
X	Number of Valid Responses	85		85	86	86	89	88
X	Number of "No Opinion" *	-		-	-	-	-	-
X	Number of "Blank Responses"	4		4	3	3	0	1
X	Percent Responding 1	6		5	2	1	5	0
X	" " 2	8		23	19	12	9	8
X	" " 3	58		28	41	48	40	58
X	" " 4	22		33	22	23	29	28
X	" " 5	6		11	16	16	17	6
X	" " 6	-		-	-	-	-	-
X	σ - Distance from Mean 1	-1.99		-2.10	-2.44	-2.70	-2.10	-3.0
X	" " " " 2	-1.28		-1.01	-1.26	-1.54	-1.33	-1.86
X	" " " " 3	-.198		-.203	-.225	-.361	-.436	-.379
X	" " " " 4	.99		.63	.62	.61	.50	.88
X	" " " " 5	1.99		1.71	1.52	1.52	1.49	1.99
X	" " " " 6	-		-	-	-	-	-
X	Standard Score (SS) 1	30.1		29.0	25.6	23.0	29.0	20.0
X	" " 2	37.2		39.9	37.4	34.6	36.7	31.4
X	" " 3	48.0		48.0	47.8	46.4	45.6	46.2
X	" " 4	59.9		56.3	56.2	56.1	55.0	58.8
X	" " 5	69.9		67.1	65.2	65.2	64.9	69.9
X	" " 6	-		-	-	-	-	-
X	Sum of (Frequency × SS)	4250.5		4246.3	4303.2	4306.2	4454.7	4395.5
X	Mean Standard Score	50.01		49.46	50.04	50.07	50.05	49.95
Y	Response 1 Very Satisfied	0		6	4	2	0	6
Y	" 2 Satisfied	10		27	13	4	5	7
Y	" 3 Neutral	37		27	45	45	26	66
Y	" 4 Dissatisfied	42		28	27	36	22	21
Y	" 5 Very Dissatisfied	23		18	17	18	57	11
Y	" 6 -	-		-	-	-	-	-
Y	Number of Valid Responses	112		106	106	105	110	111
Y	Number of "No Opinion" *	-		-	-	-	-	-
Y	Number of "Blank Responses"	0		6	6	7	2	1
Y	Percent Responding 1	0		6	4	2	0	5
Y	" " 2	9		25	12	4	5	6
Y	" " 3	33		25	42	43	24	59
Y	" " 4	38		26	25	34	20	19
Y	" " 5	21		17	16	17	52	10
Y	" " 6	-		-	-	-	-	-
Y	Sum of (Frequency × SS)	6271.5		5331.5	5365.4	5465.6	6278.4	5392.7
Y	Mean Standard Score	56.00		50.30	50.62	52.05	57.08	48.58
	Estimate of Std. Deviat.	9.95		10.63	9.56	8.80	9.13	11.49
	t Statistic	67.43		3.40	6.43	23.65	84.63	-13.19
	Significance Level of Change	0.001		0.001	0.001	0.001	0.001	0.001

* Response "No Opinion" is not used in Physician's Questionnaire Part 1.

[†] Question 14 is a "Yes" or "No" question, and hence not scored.

TABLE D-1 (cont.)

STATISTICAL DATA FROM PHYSICIAN'S QUESTIONNAIRE PART 1

Data Coll. Pd.	Item \ Question Number	20	21	22	23	24	25
X	Response 1 Very Satisfied	1	3	8	3	1	11
X	" 2 Satisfied	3	5	35	10	36	23
X	" 3 Neutral	45	65	31	29	27	47
X	" 4 Dissatisfied	29	13	10	34	18	6
X	" 5 Very Dissatisfied	7	3	3	13	5	2
X	" 6 -	-	-	-	-	-	-
X	Number of Valid Responses	85	89	87	89	87	89
X	Number of "No Opinion" *	-	-	-	-	-	-
X	Number of "Blank Responses"	4	0	2	0	2	0
X	Percent Responding 1	1	3	9	3	1	12
X	" " 2	4	6	40	11	41	26
X	" " 3	53	73	36	33	31	53
X	" " 4	34	15	12	38	21	7
X	" " 5	8	3	3	15	6	2
X	" " 6	-	-	-	-	-	-
X	σ - Distance from Mean 1	-2.70	-2.28	-1.81	-2.28	-2.70	-1.67
X	" " " " 2	-1.91	-1.57	-.59	-1.40	-.89	-.70
X	" " " " 3	-.545	-.137	.457	-.53	.197	.415
X	" " " " 4	.71	1.29	1.38	.429	1.01	1.63
X	" " " " 5	1.86	2.28	2.28	1.56	1.99	2.44
X	" " " " 6	-	-	-	-	-	-
X	Standard Score (SS) 1	23.0	27.2	31.9	27.2	23.0	33.3
X	" " 2	30.9	34.3	44.1	36.0	41.1	43.0
X	" " 3	44.6	48.6	54.6	44.7	52.0	54.2
X	" " 4	57.1	62.9	63.8	54.3	60.1	66.3
X	" " 5	68.6	72.8	72.8	65.6	69.9	74.4
X	" " 6	-	-	-	-	-	-
X	Sum of (Frequency × SS)	4258.8	4448.2	4347.7	4436.9	4337.9	4449.3
X	Mean Standard Score	50.10	49.98	49.97	49.85	49.86	49.99
Y	Response 1 Very Satisfied	5	19	9	2	5	14
Y	" 2 Satisfied	9	28	33	7	43	28
Y	" 3 Neutral	63	42	37	21	36	51
Y	" 4 Dissatisfied	23	10	20	38	16	12
Y	" 5 Very Dissatisfied	7	11	12	44	9	5
Y	" 6 -	-	-	-	-	-	-
Y	Number of Valid Responses	107	110	111	112	109	110
Y	Number of "No Opinion" *	-	-	-	-	-	-
Y	Number of "Blank Responses"	5	2	1	0	3	2
Y	Percent Responding 1	5	17	8	2	5	13
Y	" " 2	8	25	30	6	39	25
Y	" " 3	59	38	33	19	33	46
Y	" " 4	21	9	18	34	15	11
Y	" " 5	7	10	11	39	8	5
Y	" " 6	-	-	-	-	-	-
Y	Sum of (Frequency × SS)	4996.4	4948.2	5992.2	6194.9	5345.0	5602.0
Y	Mean Standard Score	46.70	44.98	53.26	55.31	49.04	50.93
	Estimate of Std. Deviat.	10.27	14.04	11.18	10.07	10.67	10.60
	t Statistic	-35.51	-39.15	32.66	60.72	-8.42	9.70
	Significance Level of Change	0.001	0.001	0.001	0.001	0.001	0.001

* Response "No Opinion" is not used in Physician's Questionnaire Part 1.

TABLE D-1 (cont.)

STATISTICAL DATA FROM PHYSICIAN'S QUESTIONNAIRE PART 1

Data Coll. Pd.	Question Number / Item	26	27	28	29	30	31
X	Response 1 Very Satisfied	1	5	10	1	5	0
X	" 2 Satisfied	5	25	37	24	19	7
X	" 3 Neutral	48	26	24	46	51	55
X	" 4 Dissatisfied	21	21	13	14	13	20
X	" 5 Very Dissatisfied	8	12	5	1	0	5
X	" 6 -	-	-	-	-	-	-
X	Number of Valid Responses	83	89	89	86	88	87
X	Number of "No Opinion" *	-	-	-	-	-	-
X	Number of "Blank Responses"	6	0	0	3	1	2
X	Percent Responding 1	1	6	1	1	6	0
X	" " 2	6	28	42	28	21	8
X	" " 3	58	29	27	54	58	63
X	" " 4	25	24	14	16	15	23
X	" " 5	10	13	6	1	0	6
X	" " 6	-	-	-	-	-	-
X	σ - Distance from Mean 1	-2.70	-1.99	-1.71	-2.70	-1.99	-3.0
X	" " " " 2	-1.79	-.88	-.498	-1.13	-1.01	-1.86
X	" " " " 3	-.411	-.0386	.44	.164	.165	-.310
X	" " " " 4	.78	.69	1.15	1.41	1.56	.97
X	" " " " 5	1.76	1.63	1.99	2.70	3.0	1.99
X	" " " " 6	-	-	-	-	-	-
X	Standard Score (SS) 1	23.0	30.1	32.9	23.0	30.1	20.0
X	" " 2	32.1	41.2	45.0	38.7	39.9	31.4
X	" " 3	45.9	49.6	54.4	51.6	51.7	46.9
X	" " 4	57.8	56.9	61.5	64.1	65.6	59.7
X	" " 5	67.6	66.3	69.9	77.0	80.0	69.9
X	" " 6	-	-	-	-	-	-
X	Sum of (Frequency × SS)	4141.3	4460.6	4448.6	4299.8	4398.1	4342.8
X	Mean Standard Score	49.90	50.12	49.98	50.00	49.98	49.92
Y	Response 1 Very Satisfied	6	6	5	1	28	1
Y	" 2 Satisfied	16	23	33	16	40	4
Y	" 3 Neutral	57	33	30	47	28	49
Y	" 4 Dissatisfied	16	25	15	28	11	33
Y	" 5 Very Dissatisfied	12	21	28	18	3	22
Y	" 6 -	-	-	-	-	-	-
Y	Number of Valid Responses	107	108	111	110	110	109
Y	Number of "No Opinion" *	-	-	-	-	-	-
Y	Number of "Blank Responses"	5	4	1	2	2	3
Y	Percent Responding 1	6	6	5	1	25	1
Y	" " 2	15	21	30	15	36	4
Y	" " 3	53	31	27	43	15	45
Y	" " 4	15	23	14	25	10	30
Y	" " 5	11	19	25	16	3	20
Y	" " 6	-	-	-	-	-	-
Y	Sum of (Frequency × SS)	5003.9	5579.8	6161.2	6248.2	4848.0	5951.6
Y	Mean Standard Score	46.77	51.66	55.51	56.80	44.07	54.60
	Estimate of Std. Deviat.	11.50	9.97	10.69	12.30	12.40	10.66
	t Statistic	-29.17	16.75	57.33	60.85	-52.39	47.92
	Significance Level of Change	0.001	0.001	0.001	0.001	0.001	0.001

* Response "No Opinion" is not used in Physician's Questionnaire Part 1.

TABLE D-1 (cont.)

STATISTICAL DATA FROM PHYSICIAN'S QUESTIONNAIRE PART 1

Data Coll. Pd.	Item \ Question Number	32	33	34	35	36	37
X	Response 1 Very Satisfied	1	0	2	0	5	6
X	" 2 Satisfied	6	8	47	5	12	25
X	" 3 Neutral	52	46	30	22	61	40
X	" 4 Dissatisfied	24	29	5	18	9	12
X	" 5 Very Dissatisfied	4	4	1	43	1	5
X	" 6 -	-	-	-	-	-	-
X	Number of Valid Responses	87	87	85	88	88	88
X	Number of "No Opinion" *	-	-	-	-	-	-
X	Number of "Blank Responses"	2	2	4	1	1	1
X	Percent Responding 1	1	0	2	0	6	7
X	" " 2	7	9	56	6	14	28
X	" " 3	60	53	35	25	69	45
X	" " 4	27	33	6	20	10	14
X	" " 5	5	5	1	49	1	6
X	" " 6	-	-	-	-	-	-
X	σ - Distance from Mean 1	-2.70	-3.0	-2.44	-3.0	-1.99	-1.92
X	" " " 2	-1.74	-1.81	-.61	-1.99	-1.15	-.84
X	" " " 3	-.351	-.415	.73	-.93	.131	.203
X	" " " 4	.94	.84	1.79	-.228	1.61	1.15
X	" " " 5	2.10	2.10	2.70	.81	2.70	1.99
X	" " " 6	-	-	-	-	-	-
X	Standard Score (SS) 1	23.0	20.0	25.6	20.0	30.1	30.8
X	" " 2	32.6	31.9	43.9	30.1	38.5	41.6
X	" " 3	46.5	45.9	57.3	40.7	51.3	52.0
X	" " 4	59.4	58.4	67.9	47.7	66.1	61.5
X	" " 5	71.0	71.0	77.0	58.1	77.0	69.9
X	" " 6	-	-	-	-	-	-
X	Sum of (Frequency × SS)	4346.2	4344.2	4250.0	4402.8	4413.7	4392.3
X	Mean Standard Score	49.96	49.93	50.00	50.03	50.16	49.91
Y	Response 1 Very Satisfied	0	1	1	1	6	2
Y	" 2 Satisfied	6	3	30	8	12	28
Y	" 3 Neutral	47	38	37	22	78	33
Y	" 4 Dissatisfied	36	43	23	39	10	28
Y	" 5 Very Dissatisfied	21	25	17	40	4	18
Y	" 6 -	-	-	-	-	-	-
Y	Number of Valid Responses	110	110	108	110	110	109
Y	Number of "No Opinion" *	-	-	-	-	-	-
Y	Number of "Blank Responses"	2	2	4	2	2	3
Y	Percent Responding 1	0	1	1	1	5	2
Y	" " 2	5	3	28	7	11	26
Y	" " 3	43	35	34	20	71	30
Y	" " 4	33	39	21	35	9	26
Y	" " 5	19	23	16	36	4	17
Y	" " 6	-	-	-	-	-	-
Y	Sum of (Frequency × SS)	6010.5	6146.1	6333.4	5340.5	5613.0	5922.6
Y	Mean Standard Score	54.64	55.87	58.64	48.55	51.03	54.34
	Estimate of Std. Deviat.	10.69	10.83	11.99	8.87	9.33	10.38
	t Statistic	48.19	60.33	77.86	-18.38	10.28	46.47
	Significance Level of Change	0.001	0.001	0.001	0.001	0.001	0.001

* Response "No Opinion" is not used in Physician's Questionnaire Part 1.

TABLE D-2

STATISTICAL DATA FROM PHYSICIAN'S QUESTIONNAIRE PART 2

Data Coll. Pd.	Item \ Question Number	1	2 *	3	4	5	6
X	Response 1 Very Favorable	26		33	19	27	10
X	" 2 Favorable	27		22	26	29	28
X	" 3 No Change	10		12	19	6	22
X	" 4 Unfavorable	0		0	0	1	1
X	" 5 Very Unfavorable	1		0	0	0	0
X	Number of Valid Responses	64		67	64	63	61
X	Number of "No Opinion"	23		20	23	24	26
X	Number of "Blank Responses"	2		2	2	2	2
X	Percent Responding 1	41		49	30	43	16
X	" " 2	42		33	40	46	46
X	" " 3	15		18	30	9	36
X	" " 4	0		0	0	2	2
X	" " 5	2		0	0	0	0
X	σ- Distance from Mean 1	-.95		-.81	-1.16	-.91	-1.52
X	" " " " 2	.322		.417	0	.444	-.301
X	" " " " 3	1.36		1.46	1.16	1.55	.92
X	" " " " 4	2.05		3.0	3.0	2.44	2.44
X	" " " " 5	2.44		3.0	3.0	3.0	3.0
X	Standard Score (SS) 1	40.5		41.9	38.4	40.9	34.8
X	" " 2	53.2		54.2	50.0	54.4	47.0
X	" " 3	63.6		64.6	61.6	65.5	59.2
X	" " 4	70.5		80.0	80.0	74.4	74.4
X	" " 5	74.4		80.0	80.0	80.0	80.0
X	Sum of (Frequency × SS)	3199.8		3350.3	3200.0	3149.3	3040.8
X	Mean Standard Score	50.00		50.00	50.00	49.99	49.85
Y	Response 1 Very Favorable	5	2	18	15	10	4
Y	" 2 Favorable	27	21	39	41	23	24
Y	" 3 No Change	25	32	37	35	15	35
Y	" 4 Unfavorable	18	26	5	10	35	17
Y	" 5 Very Unfavorable	30	22	6	6	19	21
Y	Number of Valid Responses	105	103	105	107	102	101
Y	Number of "No Opinion"	5	8	6	4	9	9
Y	Number of "Blank Responses"	2	1	1	1	1	2
Y	Percent Responding 1	5	2	17	14	10	4
Y	" " 2	26	21	37	38	23	24
Y	" " 3	24	31	35	33	15	35
Y	" " 4	17	25	5	9	34	17
Y	" " 5	28	21	6	6	19	21
Y	Sum of (Frequency × SS)	6729.9		6138.2	6062.0	6766.7	6284.0
Y	Mean Standard Score	64.09		58.46	56.65	66.34	62.22
	Estimate of Std. Deviat.	9.77		10.81	12.43	12.42	13.43
	t Statistic	151.57		82.16	57.26	134.28	92.99
	Significance Level of Change	0.001		0.001	0.001	0.001	0.001

* Question 2 is not included in the analysis because it contained a typographical error in period X.

TABLE D-2 (cont.)

STATISTICAL DATA FROM PHYSICIAN'S QUESTIONNAIRE PART 2

Data Coll. Pd.	Question Number / Item	7	8	9	10	11	12
X	Response 1 Very Favorable	46	26	36	45	11	22
X	" 2 Favorable	15	25	26	14	23	22
X	" 3 No Change	7	12	8	7	25	12
X	" 4 Unfavorable	1	0	0	1	1	1
X	" 5 Very Unfavorable	0	0	0	0	0	1
X	Number of Valid Responses	69	63	70	67	60	58
X	Number of "No Opinion"	18	24	17	20	27	29
X	Number of "Blank Responses"	2	2	2	2	2	2
X	Percent Responding 1	67	41	51	67	18	38
X	" " 2	22	40	38	21	38	38
X	" " 3	10	19	11	11	42	20
X	" " 4	1	0	0	1	2	2
X	" " 5	0	0	0	0	0	2
X	σ- Distance from Mean 1	-.541	-.95	-.784	-.541	-1.40	-1.00
X	" " " " 2	.79	.293	.55	.77	-.349	.185
X	" " " " 3	1.61	1.43	1.71	1.58	.82	1.12
X	" " " " 4	2.70	3.0	3.0	2.70	2.44	1.89
X	" " " " 5	3.0	3.0	3.0	3.0	3.0	2.44
X	Standard Score (SS) 1	44.6	40.5	42.2	44.6	36.0	40.0
X	" " 2	57.9	52.9	55.5	57.7	46.5	51.9
X	" " 3	66.1	64.3	67.1	65.8	58.2	61.2
X	" " 4	77.0	80.0	80.0	77.0	74.4	68.9
X	" " 5	80.0	80.0	80.0	80.0	80.0	74.4
X	Sum of (Frequency × SS)	3459.8	3147.1	3499.0	3352.4	2294.9	2899.5
X	Mean Standard Score	50.14	49.95	49.99	50.04	49.92	49.99
Y	Response 1 Very Favorable	16	2	7	13	2	3
Y	" 2 Favorable	38	12	22	34	19	15
Y	" 3 No Change	21	37	33	21	50	17
Y	" 4 Unfavorable	12	15	24	13	19	26
Y	" 5 Very Unfavorable	18	35	20	25	13	33
Y	Number of Valid Responses	105	101	106	106	103	94
Y	Number of "No Opinion"	5	10	5	4	7	17
Y	Number of "Blank Responses"	2	1	1	2	2	1
Y	Percent Responding 1	15	2	7	12	2	3
Y	" " 2	36	12	21	32	18	16
Y	" " 3	20	37	31	20	49	18
Y	" " 4	11	15	23	12	18	28
Y	" " 5	17	35	19	24	13	35
Y	Sum of (Frequency × SS)	6665.9	7094.9	7250.7	6924.4	6319.1	6185.5
Y	Mean Standard Score	63.48	70.25	68.40	65.32	61.35	65.80
	Estimate of Std. Deviat.	11.66	10.70	11.73	11.84	11.60	9.24
	t Statistic	120.1	191.58	166.46	136.87	101.53	160.80
	Significance Level of Change	0.001	0.001	0.001	0.001	0.001	0.001

TABLE D-2 (cont.)

STATISTICAL DATA FROM PHYSICIAN'S QUESTIONNAIRE PART 2

Data Coll. Pd.	Item \ Question Number	13	14	15	16	17	18
X	Response 1 Very Favorable	11	6	28	24	14	31
X	" 2 Favorable	37	24	18	25	39	18
X	" 3 No Change	20	32	11	9	8	9
X	" 4 Unfavorable	0	1	2	2	0	3
X	" 5 Very Unfavorable	0	1	0	0	0	0
X	Number of Valid Responses	68	64	59	60	61	61
X	Number of "No Opinion"	19	23	28	27	25	26
X	Number of "Blank Responses"	2	2	2	2	3	2
X	Percent Responding 1	16	9	47	40	23	51
X	" " 2	55	38	31	42	64	29
X	" " 3	29	49	19	15	13	15
X	" " 4	0	2	3	3	0	5
X	" " 5	0	2	0	0	0	0
X	σ- Distance from Mean 1	-1.52	-1.81	-.85	-.97	-1.32	-.784
X	" " " " 2	-.181	-.62	.329	.297	.147	.41
X	" " " " 3	1.18	.635	1.20	1.29	1.63	1.18
X	" " " " 4	3.0	1.89	2.28	2.28	3.0	2.10
X	" " " " 5	3.0	2.44	3.0	3.0	3.0	3.0
X	Standard Score (SS) 1	34.8	31.9	41.5	40.3	36.8	42.2
X	" " 2	48.2	43.8	53.3	53.0	51.5	54.1
X	" " 3	61.8	56.4	62.0	62.9	66.3	61.8
X	" " 4	80.0	68.9	72.8	72.8	80.0	71.0
X	" " 5	80.0	74.4	80.0	80.0	80.0	80.0
X	Sum of (Frequency × SS)	3402.2	3190.7	2949.0	3003.9	3054.1	3051.2
X	Mean Standard Score	50.03	49.85	49.98	50.07	50.07	50.02
Y	Response 1 Very Favorable	4	2	16	3	12	15
Y	" 2 Favorable	19	9	31	15	26	32
Y	" 3 No Change	44	54	17	37	49	15
Y	" 4 Unfavorable	22	21	18	25	5	19
Y	" 5 Very Unfavorable	16	20	24	25	7	26
Y	Number of Valid Responses	105	106	106	105	99	107
Y	Number of "No Opinion"	5	3	4	5	11	4
Y	Number of "Blank Responses"	2	3	2	2	2	1
Y	Percent Responding 1	4	2	15	3	12	14
Y	" " 2	18	8	29	14	26	30
Y	" " 3	42	51	16	35	49	14
Y	" " 4	21	20	17	24	5	18
Y	" " 5	15	19	23	24	7	24
Y	Sum of (Frequency × SS)	6814.2	6438.5	6600.7	7063.2	5989.3	6720.2
Y	Mean Standard Score	64.90	60.74	62.27	67.27	60.50	62.81
	Estimate of Std. Deviat.	13.16	9.95	13.43	10.17	12.40	12.95
	t Statistic	118.61	115.98	96.98	177.60	83.31	105.66
	Significance Level of Change	0.001	0.001	0.001	0.001	0.001	0.001

TABLE D-2 (cont.)

STATISTICAL DATA FROM PHYSICIAN'S QUESTIONNAIRE PART 2

Data Coll. Pd.	Item \ Question Number	19	20	21	22	23	24
X	Response 1 Very Favorable	25	32	20	23	18	28
X	" 2 Favorable	10	19	26	27	29	27
X	" 3 No Change	14	7	11	10	10	13
X	" 4 Unfavorable	0	0	0	1	1	0
X	" 5 Very Unfavorable	0	0	0	0	0	0
X	Number of Valid Responses	49	58	57	61	58	68
X	Number of "No Opinion"	38	29	30	25	28	18
X	Number of "Blank Responses"	2	2	2	3	3	3
X	Percent Responding 1	51	55	35	38	31	41
X	" " 2	20	33	46	44	50	40
X	" " 3	29	12	19	16	17	19
X	" " 4	0	0	0	2	2	0
X	" " 5	0	0	0	0	0	0
X	σ- Distance from Mean 1	-.784	-.722	-1.06	-1.00	-1.14	-.95
X	" " " " 2	.28	.59	.214	.272	.163	.293
X	" " " " 3	1.18	1.67	1.43	1.34	1.31	1.43
X	" " " " 4	3.0	3.0	3.0	2.44	2.44	3.0
X	" " " " 5	3.0	3.0	3.0	3.0	3.0	3.0
X	Standard Score (SS) 1	42.2	42.8	39.4	40.0	38.6	40.5
X	" " 2	52.8	55.9	52.1	52.7	51.6	52.9
X	" " 3	61.8	66.7	64.3	63.4	63.1	64.3
X	" " 4	80.0	80.0	80.0	74.4	74.4	80.0
X	" " 5	80.0	80.0	80.0	80.0	80.0	80.0
X	Sum of (Frequency × SS)	2448.2	2898.6	2849.9	3051.3	2896.6	3398.2
X	Mean Standard Score	49.96	49.98	50.00	50.02	49.94	49.97
Y	Response 1 Very Favorable	7	12	1	7	2	44
Y	" 2 Favorable	18	31	9	19	16	35
Y	" 3 No Change	39	19	40	33	37	13
Y	" 4 Unfavorable	12	21	18	24	26	7
Y	" 5 Very Unfavorable	23	16	30	19	21	6
Y	Number of Valid Responses	99	99	98	102	102	105
Y	Number of "No Opinion"	12	11	13	9	9	5
Y	Number of "Blank Responses"	1	2	1	1	1	2
Y	Percent Responding 1	7	12	1	7	2	42
Y	" " 2	18	31	9	19	16	33
Y	" " 3	39	19	41	32	36	12
Y	" " 4	12	21	18	24	25	7
Y	" " 5	23	16	31	19	21	6
Y	Sum of (Frequency × SS)	6456.0	6473.8	6920.3	6679.1	6851.9	5509.4
Y	Mean Standard Score	65.21	65.39	70.62	65.48	67.18	52.47
	Estimate of Std. Deviat.	12.20	13.11	10.09	11.65	10.41	13.15
	t Statistic	123.73	116.41	200.17	135.37	168.90	19.94
	Significance Level of Change	0.001	0.001	0.001	0.001	0.001	0.001

TABLE D-2 (cont.)

STATISTICAL DATA FROM PHYSICIAN'S QUESTIONNAIRE PART 2

Data Coll. Pd.	Question Number / Item	25	26	27	28	29	30	31 *
X	Response 1 Very Favorable	27	25	27	8	18	44	
X	" 2 Favorable	27	18	19	23	20	24	
X	" 3 No Change	12	11	15	23	23	6	
X	" 4 Unfavorable	1	1	0	1	1	1	
X	" 5 Very Unfavorable	0	0	0	0	0	0	
X	Number of Valid Responses	67	55	61	55	62	75	
X	Number of "No Opinion"	19	31	25	30	25	12	
X	Number of "Blank Responses"	3	3	3	4	2	2	
X	Percent Responding 1	40	45	44	15	29	59	
X	" " 2	41	33	31	41	32	32	
X	" " 3	18	20	25	42	37	8	
X	" " 4	1	2	0	2	2	1	
X	" " 5	0	0	0	0	0	0	
X	σ- Distance from Mean 1	-.97	-.88	-.90	-1.56	-1.18	-.661	
X	" " " " 2	.278	.305	.243	-.390	-.129	.71	
X	" " " " 3	1.36	1.24	1.27	.82	.91	1.70	
X	" " " " 4	2.70	2.44	3.0	2.44	2.44	2.70	
X	" " " " 5	3.0	3.0	3.0	3.0	3.0	3.0	
X	Standard Score (SS) 1	40.3	41.2	41.0	34.4	38.2	43.4	
X	" " 2	52.8	53.1	52.4	46.1	48.7	57.1	
X	" " 3	63.6	62.4	62.7	58.2	59.1	67.0	
X	" " 4	77.0	74.4	80.0	74.4	74.4	77.0	
X	" " 5	80.0	80.0	80.0	80.0	80.0	80.0	
X	Sum of (Frequency × SS)	3353.9	2746.6	3043.1	2748.5	3095.3	3754.6	
X	Mean Standard Score	50.06	49.94	49.89	49.97	49.92	50.06	
Y	Response 1 Very Favorable	43	5	5	3	5	35	11
Y	" 2 Favorable	38	28	20	8	15	43	24
Y	" 3 No Change	11	34	29	34	51	15	45
Y	" 4 Unfavorable	6	18	22	38	15	4	9
Y	" 5 Very Unfavorable	8	15	29	19	18	8	13
Y	Number of Valid Responses	106	100	105	102	104	105	102
Y	Number of "No Opinion"	5	11	6	9	6	6	8
Y	Number of "Blank Responses"	1	1	1	1	2	1	2
Y	Percent Responding 1	41	5	5	3	5	33	11
Y	" " 2	36	28	19	8	14	41	23
Y	" " 3	10	34	28	33	49	14	44
Y	" " 4	6	18	21	37	14	4	9
Y	" " 5	8	15	28	19	17	8	13
Y	Sum of (Frequency × SS)	5540.9	6353.6	7151.3	6798.0	6491.6	5923.8	
Y	Mean Standard Score	52.27	63.54	68.11	66.65	62.42	56.42	
	Estimate of Std. Deviat.	12.87	10.91	12.66	12.02	11.67	11.55	
	t Statistic	18.23	124.67	151.12	141.48	111.32	57.80	
	Significance Level of Change	0.001	0.001	0.001	0.001	0.001	0.001	

* Question 31 was only on the period Y version of the questionnaire.

TABLE D-3

STATISTICAL DATA FROM REGISTERED NURSING STAFF QUESTIONNAIRE

Data Coll. Pd.	Item \ Question Number	1	2	3	4	5	6
X	Response 1 Very Favorable	41	35	48	34	46	30
X	" 2 Favorable	18	17	26	16	26	15
X	" 3 No Change	10	22	3	22	5	22
X	" 4 Unfavorable	2	1	2	1	0	2
X	" 5 Very Unfavorable	6	0	0	1	0	2
X	Number of Valid Responses	77	75	79	74	77	71
X	Number of "No Opinion"	28	30	26	31	28	34
X	Number of "Blank Responses"	0	0	0	0	0	0
X	Percent Responding 1	53	47	61	46	60	42
X	" " 2	23	23	33	22	34	21
X	" " 3	13	29	4	30	6	31
X	" " 4	3	1	2	1	0	3
X	" " 5	8	0	0	1	0	3
X	σ- Distance from Mean 1	-0.75	-0.85	-0.63	-0.86	-0.64	-0.93
X	" " " " 2	0.38	0.21	0.77	0.18	0.79	0.63
X	" " " " 3	0.94	1.11	1.63	1.03	1.97	0.84
X	" " " " 4	1.32	2.64	2.27	2.24	3.00	1.67
X	" " " " 5	1.85	3.00	3.00	2.64	3.00	2.27
X	Standard Score (SS) 1	43	42	44	41	44	41
X	" " 2	54	52	58	52	58	51
X	" " 3	59	61	66	60	70	58
X	" " 4	63	76	73	72	80	67
X	" " 5	68	80	80	76	80	73
X	Sum of (Frequency × SS)	3842.5	3761.0	3939.7	3710.5	3857.4	3543.2
X	Mean Standard Score	49.90	50.15	49.87	50.14	50.10	49.90
Y	Response 1 Very Favorable	3	4	4	5	0	2
Y	" 2 Favorable	12	12	18	11	11	14
Y	" 3 No Change	24	17	7	17	21	27
Y	" 4 Unfavorable	8	12	15	17	12	7
Y	" 5 Very Unfavorable	14	16	14	11	18	7
Y	Number of Valid Responses	61	61	58	61	62	57
Y	Number of "No Opinion"	12	12	14	12	11	16
Y	Number of "Blank Responses"	0	0	1	0	0	0
Y	Percent Responding 1	5	6	7	8	0	4
Y	" " 2	20	20	31	18	18	25
Y	" " 3	39	28	12	28	34	47
Y	" " 4	13	20	26	28	19	12
Y	" " 5	23	26	24	18	29	12
Y	Sum of (Frequency × SS)	3663.9	4027.7	3887.8	3872.4	4500.4	3342.0
Y	Mean Standard Score	60.06	66.03	67.03	63.48	72.59	58.63
	Estimate of Std. Deviat.	6.41	12.61	10.76	11.03	8.30	7.77
	t Statistic	96.63	76.80	92.48	73.76	168.10	64.02
	Significance Level of Change	0.001	0.001	0.001	0.001	0.001	0.001

TABLE D-3 (cont.)

STATISTICAL DATA FROM REGISTERED NURSING STAFF QUESTIONNAIRE

Data Coll. Pd.	Item \ Question Number	7	8	9	10	11	12
X	Response 1 Very Favorable	29	13	26	45	24	31
X	" 2 Favorable	41	28	15	30	19	26
X	" 3 No Change	7	25	27	1	24	13
X	" 4 Unfavorable	1	1	0	0	3	1
X	" 5 Very Unfavorable	0	0	0	1	0	0
X	Number of Valid Responses	78	67	68	77	70	71
X	Number of "No Opinion"	27	38	37	28	35	32
X	Number of "Blank Responses"	0	0	0	0	0	2
X	Percent Responding 1	37	19	38	58	34	44
X	" " 2	53	42	22	39	27	37
X	" " 3	9	37	40	1	35	18
X	" " 4	1	2	0	0	4	1
X	" " 5	0	0	0	1	0	0
X	σ- Distance from Mean 1	-1.02	-1.48	-1.00	-0.67	-1.09	-0.90
X	" " " " 2	.38	-0.24	-0.03	0.87	-0.04	0.33
X	" " " " 3	1.66	0.96	.97	2.24	0.86	1.36
X	" " " " 4	2.64	2.64	3.00	2.33	2.16	2.64
X	" " " " 5	3.00	3.00	3.00	2.64	3.00	3.00
X	Standard Score (SS) 1	40	35	40	43	39	41
X	" " 2	54	48	50	59	50	53
X	" " 3	67	60	60	72	59	64
X	" " 4	76	76	80	73	72	76
X	" " 5	80	80	80	76	80	80
X	Sum of (Frequency × SS)	3902.8	3357.1	3396.5	3858.7	3503.8	3561.9
X	Mean Standard Score	50.04	50.11	49.95	50.11	50.06	50.17
Y	Response 1 Very Favorable	1	2	6	8	3	25
Y	" 2 Favorable	18	8	9	20	13	13
Y	" 3 No Change	27	37	32	13	17	8
Y	" 4 Unfavorable	7	9	5	13	18	12
Y	" 5 Very Unfavorable	9	4	4	10	12	6
Y	Number of Valid Responses	62	60	56	64	63	64
Y	Number of "No Opinion"	11	13	17	9	10	8
Y	Number of "Blank Responses"	0	0	0	0	0	1
Y	Percent Responding 1	2	3	11	13	5	39
Y	" " 2	29	13	16	31	21	20
Y	" " 3	44	62	57	20	27	13
Y	" " 4	11	15	9	20	28	19
Y	" " 5	14	7	7	16	19	9
Y	Sum of (Frequency × SS)	4061.6	3663.1	3316.7	4178.6	4007.5	3625.1
Y	Mean Standard Score	65.51	61.05	59.23	65.29	63.61	56.64
	Estimate of Std. Deviat.	9.82	10.43	11.22	10.88	12.13	15.22
	t Statistic	97.71	62.96	46.31	89.27	70.39	27.23
	Significance Level of Change	0.001	0.001	0.001	0.001	0.001	0.001

TABLE D-3 (cont.)

STATISTICAL DATA FROM REGISTERED NURSING STAFF QUESTIONNAIRE

Data Coll. Pd.	Question Number / Item	13	14	15	16
X	Response 1 Very Favorable	26	26	29	41
X	" 2 Favorable	14	10	20	16
X	" 3 No Change	19	33	14	12
X	" 4 Unfavorable	0	3	1	1
X	" 5 Very Unfavorable	0	0	0	0
X	Number of Valid Responses	59	72	64	70
X	Number of "No Opinion"	44	30	38	32
X	Number of "Blank Responses"	2	3	3	3
X	Percent Responding 1	44	36	45	59
X	" " 2	24	14	31	23
X	" " 3	32	46	22	17
X	" " 4	0	4	2	1
X	" " 5	0	0	0	0
X	σ- Distance from Mean 1	-0.90	-1.04	-0.88	-0.66
X	" " " " 2	0.16	-0.18	0.28	0.55
X	" " " " 3	1.12	0.68	1.19	1.38
X	" " " " 4	3.00	2.16	2.44	2.64
X	" " " " 5	3.00	3.00	3.00	3.00
X	Standard Score (SS) 1	41	40	41	43
X	" " 2	52	48	53	56
X	" " 3	61	57	62	64
X	" " 4	80	72	74	76
X	" " 5	80	80	80	80
X	Sum of (Frequency × SS)	2950.1	3601.1	3190.9	3510.7
X	Mean Standard Score	50.01	50.16	49.86	50.15
Y	Response 1 Very Favorable	1	18	2	5
Y	" 2 Favorable	8	18	15	8
Y	" 3 No Change	38	11	28	23
Y	" 4 Unfavorable	5	11	1	10
Y	" 5 Very Unfavorable	2	4	9	14
Y	Number of Valid Responses	54	62	55	60
Y	Number of "No Opinion"	18	9	17	12
Y	Number of "Blank Responses"	1	2	1	1
Y	Percent Responding 1	2	29	4	9
Y	" " 2	15	29	27	13
Y	" " 3	70	18	51	38
Y	" " 4	9	18	2	17
Y	" " 5	4	6	16	23
Y	Sum of (Frequency × SS)	3337.7	3312.9	3400.7	4013.3
Y	Mean Standard Score	61.81	53.43	61.83	66.89
	Estimate of Std. Deviat.	8.25	13.12	9.83	11.14
	t Statistic	77.23	16.16	67.02	90.15
	Significance Level of Change	0.001	0.001	0.001	0.001

TABLE D - 4

STATISTICAL DATA FROM LABORATORY STAFF QUESTIONNAIRE PART 1

Question Number	Number of Responses from Period X						Number of Responses from Period Y					
	Agree			Disagree		Blanks	Agree			Disagree		Blanks
	Strongly Agree		Uncertain		Strongly Disagree		Strongly Agree		Uncertain		Strongly Disagree	
1	27	21	2	3	0	1	35	26	0	0	0	0
2	6	24	11	5	7	0	8	23	10	13	7	0
3	7	26	13	6	1	1	7	32	12	9	1	1
4	2	32	8	8	3	0	8	22	11	18	2	1
5	15	26	5	4	3	0	26	26	7	2	0	1
6	1	3	22	15	12	1	2	7	23	16	13	0
7	13	27	3	9	1	0	21	30	5	3	2	1
8	10	35	1	7	0	0	23	31	5	1	1	1
9	13	35	2	3	0	0	22	34	1	4	0	0
10	4	30	10	8	1	2	20	25	9	6	1	0
11	1	12	17	12	11	2	4	21	15	15	6	0
12	10	26	4	11	2	0	15	34	3	7	2	2
13	0	18	18	15	2	2	5	18	14	20	4	0
14	7	27	9	8	2	1	17	23	5	12	4	0
15	5	18	4	25	1	1	10	16	12	20	3	0
16	10	26	3	12	2	1	12	39	1	7	2	1
17	9	39	0	4	1	0	21	32	5	2	1	1
18	1	30	4	15	3	0	8	34	4	12	3	0
19	5	32	2	12	2	2	8	30	11	9	3	3
20	4	29	15	3	2	1	4	35	9	9	3	3
21	9	34	7	3	0	2	15	37	6	3	0	2
22	9	33	5	5	1	2	11	34	8	6	2	1
23	0	3	10	24	16	1	0	7	14	15	25	1

TABLE D - 5

STATISTICAL DATA FROM LABORATORY STAFF QUESTIONNAIRE PART 2

Question Number	Number of Responses from Period X*									Number of Responses from Period Y*								
	One	Two	Three	Four	Five	Six	Yes	No	Blanks	One	Two	Three	Four	Five	Six	Yes	No	Blanks
1	0	13	28	6	5	0	0	0	1	0	6	23	19	13	0	0	0	0
2	2	15	20	8	6	0	0	0	2	0	8	27	14	12	0	0	0	0
3	27	3	1	0	2	17	0	0	3	23	10	1	1	3	20	0	0	3
4	49	0	0	0	0	3	0	0	1	57	1	2	1	0	0	0	0	0
5	21	14	5	5	6	0	0	0	2	14	19	9	12	5	0	0	0	2
6	0	0	22	22	8	0	0	0	1	0	6	11	28	16	0	0	0	0
7	2	3	20	18	9	0	0	0	1	0	2	16	16	27	0	0	0	0
8	6	11	11	14	11	0	0	0	0	1	14	8	20	18	0	0	0	0
9	0	2	13	22	12	2	0	0	2	1	1	13	22	23	1	0	0	0
10	5	12	25	2	2	4	0	0	3	5	5	24	7	6	14	0	0	0
11	1	18	8	12	6	4	0	0	4	1	12	10	12	22	4	0	0	0
12	0	19	10	12	3	6	0	0	3	0	15	13	13	12	8	0	0	0
13	Factual Question Concerning Rank																	
14	Factual Question Concerning Air Force Specialty Code (AFSC) number																	
15	0	0	0	0	0	0	8	45	0	0	0	0	0	0	0	19	41	1
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	36	0

*Numbers One, Two, etc., above columns designate each of the several possible responses to the questions as presented in the questionnaire. The responses are numbered in the order they appear in the questionnaire.

TABLE D - 6

STATISTICAL DATA FROM PATIENT QUESTIONNAIRE

Question Number	Number of Responses from Period X					Number of Responses from Period Y				
				Disagree					Disagree	
	Strongly Agree	Agree	No Opinion		Strongly Disagree	Strongly Agree	Agree	No Opinion		Strongly Disagree
1	46	86	41	9	0	34	101	61	13	2
2	31	77	16	47	11	16	58	23	88	26
3	54	56	60	10	2	33	74	79	16	9
4	47	87	32	12	4	22	117	56	13	3
5	48	84	34	13	3	28	109	42	27	5
6	45	91	29	16	1	24	121	32	30	4
7	42	61	75	4	0	21	70	112	5	3
8	40	75	52	10	5	23	87	86	11	4
9	40	84	38	16	4	27	108	48	22	6
10	58	78	24	25	5	32	93	30	45	11
11	49	87	40	4	2	41	102	48	15	5
12	41	86	33	19	3	32	100	47	27	5
13	45	71	43	19	4	21	93	58	27	12
14	38	72	40	31	1	27	98	37	44	5
15	28	35	98	15	6	18	37	129	16	11
16	YES 26	NO 156	0	0	0	YES 21	NO 181	9	0	0

REFERENCES

(1) R. C. Brooks, R. G. Carlisle, I. J. Casey, and P. W. Blackmon, Jr. HSDN 77-3—Evaluation Plan for the Air Force Clinical Laboratory Automation System (AFCLAS). Falls Church, Virginia: Analytic Services Inc., 1975.

APPENDIX E

SURVEY QUESTIONNAIRES

The schedules (questionnaires) in this appendix are designed to measure attitudes toward the clinical laboratory and acceptance of AFCLAS. The schedules were designed not to prove some expected dramatic changes, but rather to measure change, if in fact there is change.

PHYSICIAN'S QUESTIONNAIRE #1

Instructions

1. Complete the first questionnaire based upon your knowledge and personal experience with the clinical laboratories at the Wright-Patterson Medical Center and other clinical laboratories (Air Force and non-Air Force).

2. Then complete the second attached questionnaire entitled "Physician's Questionnaire #2—AFCLAS."

3. Finally, insert the completed questionnaire into the accompanying envelope, seal the envelope, and print the following information on the front of the envelope:

Name
Department.

This information will be used only to ensure that responses from all physicians at Wright-Patterson Medical Center will be included in the study. The sealed envelope will be opened only by the research team of Analytic Services Inc. (ANSER), and the information you provide will be available only to the team.

1. Laboratory reports at this hospital are

- ☐ much more
- ☐ somewhat more
- ☐ about as
- ☐ somewhat less
- ☐ much less

} legible than (as) clinical laboratory reports elsewhere.

2. At the Wright-Patterson Medical Center I have

- ☐ much more
- ☐ more
- ☐ about as much
- ☐ less
- ☐ much less

} confidence in the clinical laboratory information I use with my patients than (as) I have had at other hospitals.

3. Overall, with respect to my experience with the clinical laboratory at the Wright-Patterson Medical Center, I am

- ☐ completely satisfied.
- ☐ well satisfied.
- ☐ reasonably satisfied.
- ☐ somewhat dissatisfied.
- ☐ completely dissatisfied.

4. At the Wright-Patterson Medical Center, the response time for routine laboratory results is

- ☐ much shorter than
- ☐ somewhat shorter than
- ☐ about as short as
- ☐ slightly longer than
- ☐ far longer than

} I would expect at clinical laboratories generally.

5. I am

- ☐ completely confident
- ☐ very confident
- ☐ reasonably confident
- ☐ not very confident
- ☐ not at all confident

} in the information I receive from the clinical laboratory at this hospital.

6. At the Wright-Patterson Medical Center, the response time for routine laboratory results is

- ☐ very short.
- ☐ short.
- ☐ moderate.
- ☐ long.
- ☐ very long.

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7. At this hospital, laboratory reports are lost

- ☐ much less often than
- ☐ less often than
- ☐ about as often as
- ☐ more often than
- ☐ much more often than

I would expect in this kind of hospital (Air Force and other).

8. At the Wright-Patterson Medical Center, filing of clinical laboratory reports in patients' charts is

- ☐ 100-percent complete.
- ☐ very complete.
- ☐ reasonably complete.
- ☐ somewhat incomplete.
- ☐ very incomplete.

9. At the Wright-Patterson Medical Center, it is necessary to repeat requests for laboratory work

- ☐ much less often than
- ☐ somewhat less often than
- ☐ about as often as
- ☐ somewhat more often than
- ☐ much more often than

I would expect for clinical laboratories of this kind (Air Force and other).

10. During the last week, I called the clinical laboratory

- ☐ none
- ☐ 1-5 times
- ☐ 6-10 times
- ☐ 11-15 times
- ☐ 16-20 times
- ☐ over 20 times

to inquire about test results.

11. During the last week,

- ☐ none
- ☐ 1-5
- ☐ 6-10
- ☐ 11-15
- ☐ 16-20
- ☐ over 20

of my clinical laboratory reports were lost.

12. During the last week, I visited the clinical laboratory to check on laboratory test status or test results on

- ☐ no
- ☐ 1-5
- ☐ 6-10
- ☐ 11-15
- ☐ 16-20
- ☐ over 20

occasions.

13. The number of errors in reports from the clinical laboratory at this hospital is

- ☐ much smaller than
- ☐ somewhat smaller than
- ☐ about the same as
- ☐ somewhat larger than
- ☐ much larger than

I would expect for clinical laboratories of this kind (Air Force and other).

14. Do you ever call the clinical laboratory to inquire about laboratory results?

- ☐ Yes
- ☐ No

If answer to question #14 is "No," go to question #18.

15. When calling the clinical laboratory at the Wright-Patterson Medical Center, I

- ☐ rarely
- ☐ occasionally
- ☐ about half the time
- ☐ very frequently
- ☐ almost every time

get a busy signal.

16. Once the telephone in the clinical laboratory is answered, there is

- ☐ a very short
- ☐ a short
- ☐ a moderate
- ☐ a long
- ☐ a very long

delay in obtaining information that I request.

17. Once the telephone in the clinical laboratory is answered, the delay in obtaining the information that I request is

- ☐ much shorter than
- ☐ shorter than
- ☐ about the same as
- ☐ longer than
- ☐ much longer than

I would expect for clinical laboratories of this kind (Air Force and other).

18. At the Wright-Patterson Medical Center, the response time for STAT results from the clinical laboratory is

- ☐ much shorter than
- ☐ somewhat shorter than
- ☐ about the same as
- ☐ slightly longer than
- ☐ far longer than

I would expect for clinical laboratories of this kind (Air Force and other).

19. Reports from the clinical laboratory at the Wright-Patterson Medical Center have

- ☐ much more
- ☐ somewhat more
- ☐ all of the
- ☐ somewhat less
- ☐ much less

clinical information than (that) I would expect in laboratory reports at this kind of hospital (Air Force and other).

20. The clinical laboratory at this hospital provides

- ☐ much more
- ☐ more
- ☐ all of the
- ☐ less
- ☐ much less

statistical information than (that) I require.

21. At the Wright-Patterson Medical Center, clinical laboratory reports are

- ☐ much more
- ☐ somewhat more
- ☐ about as
- ☐ somewhat less
- ☐ much less

readable than (as) reports from other clinical laboratories.

22. The clinical laboratory at the Wright-Patterson Medical Center makes a

- ☐ very large
- ☐ large
- ☐ moderate
- ☐ small
- ☐ very small

contribution to the quality of patient care.

23. Overall, I am

- ☐ much more
- ☐ more
- ☐ about as
- ☐ less
- ☐ much less

satisfied with the clinical laboratory at the Wright-Patterson Medical Center than (as) I have been with the clinical laboratory at other hospitals.

24. At the Wright-Patterson Medical Center, the reports from the clinical laboratory contain

- ☐ more than all of
- ☐ all of
- ☐ most, but not all, of
- ☐ somewhat less than all of
- ☐ much less than all of

the clinical information that I would like from the laboratory.

25. My relations with the clinical laboratory personnel at this hospital are

- ☐ completely satisfactory.
- ☐ very satisfactory.
- ☐ reasonably satisfactory.
- ☐ slightly unsatisfactory.
- ☐ completely unsatisfactory.

26. The clinical laboratory at this hospital provides

- ☐ much more
- ☐ somewhat more
- ☐ about as much
- ☐ somewhat less
- ☐ much less

} statistical information than (as) other clinical laboratories.

27. At this hospital, laboratory reports are lost

- ☐ rarely.
- ☐ occasionally.
- ☐ moderately often.
- ☐ often.
- ☐ very often.

28. At the Wright-Patterson Medical Center, it is necessary for me to repeat requests for laboratory work

- ☐ rarely.
- ☐ occasionally.
- ☐ moderately often.
- ☐ often.
- ☐ very often.

29. The accuracy of reports from the clinical laboratory at this hospital is

- ☐ very high.
- ☐ high.
- ☐ moderate.
- ☐ low.
- ☐ very low.

30. Laboratory reports at this hospital are

- ☐ completely legible.
- ☐ very legible.
- ☐ reasonably legible.
- ☐ slightly illegible.
- ☐ completely illegible.

31. At the Wright-Patterson Medical Center, the clinical laboratory contributes

- ☐ much more
- ☐ more
- ☐ about as much
- ☐ less
- ☐ much less

} to improved patient health than (as) clinical laboratories at similar hospitals.

32. The clinical laboratory at the Wright-Patterson Medical Center contributes

- ☐ much more
- ☐ more
- ☐ about as much
- ☐ less
- ☐ much less

} to the quality of patient care than (as) clinical laboratories at similar hospitals.

33. The accuracy of reports from the clinical laboratory at this hospital is

- ☐ much greater than
- ☐ somewhat greater than
- ☐ about the same as
- ☐ somewhat less than
- ☐ much less than

} I would expect for clinical laboratories of this kind (Air Force and other).

34. The clinical laboratory at this hospital provides reports that have

- ☐ virtually no errors.
- ☐ very few errors.
- ☐ a significant number of errors.
- ☐ many errors.
- ☐ very many errors.

35. At the Wright-Patterson Medical Center, filing of clinical laboratory reports in patients' charts is

- ☐ much more
- ☐ somewhat more
- ☐ about as
- ☐ somewhat less
- ☐ much less

} complete than (as) I would expect at a similar hospital.

36. My relations with the personnel in the clinical laboratory at this hospital are

- ☐ much more
- ☐ more
- ☐ as
- ☐ less
- ☐ much less

} satisfactory than (as) I had expected.

37. At the Wright-Patterson Medical Center, the contribution of the clinical laboratory to improved patient health is

- ☐ very large.
- ☐ large.
- ☐ moderate.
- ☐ small.
- ☐ very small.

After completing this questionnaire, please complete the "Physician Questionnaire #2—AFCLAS," which follows.

PHYSICIAN'S QUESTIONNAIRE #2—AFCLAS

A Clinical Laboratory Automation System (AFCLAS) has been installed at the Wright-Patterson Medical Center. We would like to know your opinion—as a practicing physician—of the impact AFCLAS has had on your professional activities.

1. AFCLAS has

[] significantly increased
[] slightly increased
[] had no effect on — the quality of patient care.
[] slightly decreased
[] significantly decreased

[] No opinion

2. AFCLAS has

[] virtually eliminated
[] slightly reduced
[] had no effect on — errors in clinical laboratory reports.
[] slightly increased
[] significantly increased

[] No opinion

3. AFCLAS has provided

[] much more
[] slightly more
[] about the same amount of — statistical information.
[] slightly less
[] significantly less

[] No opinion

4. AFCLAS has

[] significantly increased
[] slightly increased
[] had no effect on — the amount of information available from clinical
[] slightly decreased — laboratory reports.
[] significantly decreased

[] No opinion

5. AFCLAS is

[] far superior to
[] slightly superior to
[] about the same quality as — the previous system.
[] slightly inferior to
[] far inferior to

[] No opinion

6. AFCLAS is

[] far superior to
[] slightly superior to
[] about the same as — the previous system in providing accurate requests
[] slightly inferior to — for laboratory tests.
[] significantly inferior to

[] No opinion

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7. AFCLAS has been

[] far more effective than
[] slightly more effective than
[] about as effective as
[] slightly less effective than
[] significantly less effective than

} the previous system in retrieving test information on patients.

[] No opinion

8. AFCLAS responds to STAT requests in a way that

[] significantly improves
[] slightly improves
[] does not differ from the previous system in providing
[] slightly impairs
[] significantly impairs

} patient care.

[] No opinion

9. AFCLAS has

[] significantly improved
[] slightly improved
[] had no effect on
[] slightly impaired
[] significantly impaired

} the ability of the physician to use clinical laboratory data.

[] No opinion

10. AFCLAS has

[] significantly improved
[] slightly improved
[] had no effect on
[] slightly impaired
[] significantly impaired

} the physician's ability to locate patient's clinical laboratory data in the laboratory report.

[] No opinion

11. AFCLAS has

[] significantly increased
[] slightly increased
[] had no effect on
[] slightly decreased
[] significantly decreased

} the accuracy of clinical laboratory reports.

[] No opinion

12. With AFCLAS, the clinical laboratory

[] functions much more smoothly.
[] functions slightly more smoothly.
[] functions about the same.
[] functions slightly less smoothly.
[] functions significantly less smoothly.

[] No opinion

13. With AFCLAS, I am

[] significantly more knowledgeable
[] slightly more knowledgeable
[] about as knowledgeable as in the past
[] slightly less knowledgeable
[] significantly less knowledgeable

} about my patients.

[] No opinion

14. With AFCLAS, I am

[] much more confident with
[] slightly more confident with
[] about as confident as I was in the past with
[] slightly less confident with
[] significantly less confident with

} the clinical laboratory information that I use with my patients.

[] No opinion

15. With AFCLAS, the format of information in lab reports is

[] significantly more
[] slightly more
[] no more
[] slightly less
[] significantly less

} convenient to use than was the previous format.

[] No opinion

16. AFCLAS has

[] significantly decreased
[] slightly decreased
[] had no effect on
[] slightly increased
[] significantly increased

} the time that I have to wait for routine laboratory reports.

[] No opinion

17. AFCLAS provides statistical information that is

[] significantly more useful in
[] slightly more useful in
[] no more useful than in the past in
[] slightly less useful in
[] significantly less useful in

} patient care.

[] No opinion

18. AFCLAS has made chart reading

[] significantly easier.
[] slightly easier.
[] about as easy as before AFCLAS.
[] slightly more difficult.
[] significantly more difficult.

[] No opinion

19. AFCLAS has

[] significantly improved
[] slightly improved
[] had no effect on
[] slightly impaired
[] significantly impaired

} telephone retrieval of test information by calling the laboratory.

[] No opinion

20. AFCLAS has

[] significantly increased
[] slightly increased
[] had no effect on
[] slightly decreased
[] significantly decreased

} the speed in retrieving test information on patients.

[] No opinion

21. AFCLAS has

- [] significantly decreased
- [] slightly decreased
- [] had no effect on
- [] slightly increased
- [] significantly increased

the response time for STAT reports.

- [] No opinion

22. AFCLAS has

- [] significantly decreased
- [] slightly decreased
- [] had no effect on
- [] slightly increased
- [] significantly increased

the number of lost test reports.

- [] No opinion

23. AFCLAS has

- [] significantly decreased
- [] slightly decreased
- [] had no effect on
- [] slightly increased
- [] significantly increased

the number of repeat requests for laboratory work.

- [] No opinion

24. AFCLAS has

- [] significantly increased
- [] slightly increased
- [] had no effect on
- [] slightly decreased
- [] significantly decreased

the legibility of laboratory reports filed in the patient's medical record.

- [] No opinion

25. AFCLAS has

- [] significantly increased
- [] slightly increased
- [] had no effect on
- [] slightly decreased
- [] significantly decreased

the legibility of laboratory reports.

- [] No opinion

26. AFCLAS has

- [] significantly decreased
- [] slightly decreased
- [] had no effect on
- [] slightly increased
- [] significantly increased

the number of times that I call the laboratory to obtain test results.

- [] No opinion

27. AFCLAS has

- [] significantly decreased
- [] slightly decreased
- [] had no effect on
- [] slightly increased
- [] significantly increased

the total time that I spend obtaining and using laboratory reports.

- [] No opinion

28. AFCLAS has

[] significantly improved
[] slightly improved
[] resulted in no change in } relations between physicians and laboratory personnel.
[] slightly impaired
[] significantly impaired

[] No opinion

29. AFCLAS has

[] significantly decreased
[] slightly decreased
[] had no effect on } the number of times that I visit the laboratory to obtain test results.
[] slightly increased
[] significantly increased

[] No opinion

30. Cumulative laboratory reports provided by AFCLAS are

[] much more useful than
[] more useful than
[] about as useful as } the previous laboratory reports.
[] less useful than
[] much less useful than

[] No opinion

31. AFCLAS has

[] significantly increased
[] slightly increased
[] had no effect on } the percentage of laboratory reports filed in the patient's medical record.
[] slightly decreased
[] significantly decreased

[] No opinion

32. My primary responsibility is

[] inpatient care.
[] outpatient care.
[] other. Please specify _____

33. Were you assigned to the Wright-Patterson Medical Center during March 1975?

[] Yes
[] No

Please place your completed questionnaires into the accompanying envelope, seal the envelope, and print the following information on the front of the envelope:

Name
Department.

REGISTERED NURSING STAFF QUESTIONNAIRE

Instructions

A Clinical Laboratory Automation System (AFCLAS) has been installed at Wright-Patterson Medical Center. We would like to have your opinion—as an R.N.—of the impact AFCLAS has had on your professional activities.

Please indicate your response to each question by placing a mark in the appropriate box.

When you have completed the questionnaire, insert it in the accompanying envelope, seal the envelope, and print the following information on the front of the envelope:

Name
Department or Ward.

This information will be used only to ensure that responses from all R.N.'s at Wright-Patterson Medical Center will be included in the study. The sealed envelope will be opened only by the research team of Analytic Services Inc. (ANSER), and the information you provide will be available only to the team.

1. There has been

[] a significantly smaller
[] a somewhat smaller
[] about the same
[] a somewhat greater
[] a significantly greater

number of telephone calls for STAT results with AFCLAS.

[] No opinion

2. With AFCLAS, the time that I spend on clerical work related to laboratory reports has been

[] significantly reduced.
[] slightly reduced.
[] about the same as before AFCLAS.
[] slightly increased.
[] significantly increased.

[] No opinion

3. AFCLAS has made it

[] much easier
[] somewhat easier
[] as easy as in the past
[] somewhat more difficult
[] much more difficult

to obtain information on status of laboratory tests being performed.

[] No opinion

4. AFCLAS has

[] significantly decreased
[] slightly decreased
[] had no effect on
[] slightly increased
[] significantly increased

the total time I spend processing test requests and laboratory reports.

[] No opinion

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March W-P 1976

5. STATS are being returned

- [] much faster
- [] somewhat faster
- [] about as fast as in the past
- [] somewhat slower
- [] much slower

with AFCLAS.

- [] No opinion

6. AFCLAS has permitted me to interact

- [] much more effectively
- [] slightly more effectively
- [] about as effectively as in the past
- [] slightly less effectively
- [] much less effectively

with clinical laboratory personnel.

- [] No opinion

7. AFCLAS is

- [] far superior to
- [] superior to
- [] about the same as
- [] inferior to
- [] far inferior to

the previous system.

- [] No opinion

8. The collection of specimens has been

- [] much better organized
- [] better organized
- [] about as well organized as in the past
- [] less organized
- [] much less organized

with AFCLAS.

- [] No opinion

9. With AFCLAS, it has been

- [] much easier
- [] easier
- [] about as easy as in the past
- [] more difficult
- [] much more difficult

to tell what laboratory work is to be done on a given day.

- [] No opinion

10. AFCLAS has made it

- [] much easier
- [] somewhat easier
- [] about as easy as in the past
- [] somewhat more difficult
- [] much more difficult

to obtain information about patients' clinical laboratory results.

- [] No opinion

11. AFCLAS had made the nurses' tasks in ordering laboratory tests

- [] much easier.
- [] somewhat easier.
- [] about as easy as in the past.
- [] somewhat more difficult.
- [] much more difficult.

- [] No opinion

12. Clinical laboratory reports provided by AFCLAS are

- [] much easier
- [] somewhat easier
- [] about as easy as in the past
- [] somewhat more difficult
- [] much more difficult

to read.

- [] No opinion

13. With AFCLAS, it is

- [] significantly easier
- [] slightly easier
- [] about as easy as in the past
- [] slightly more difficult
- [] significantly more difficult

to schedule patients for laboratory procedures.

- [] No opinion

14. AFCLAS has made posting of clinical laboratory reports in a patient's chart

- [] much easier.
- [] somewhat easier.
- [] about the same as before AFCLAS.
- [] somewhat more difficult.
- [] much more difficult.

- [] No opinion

15. AFCLAS has

- [] significantly increased
- [] slightly increased
- [] had no effect on
- [] slightly decreased
- [] significantly decreased

the quality of patient care.

- [] No opinion

16. With AFCLAS, the number of telephone calls that I make to the laboratory is

- [] much smaller.
- [] slightly smaller.
- [] about the same as before AFCLAS.
- [] slightly greater.
- [] much greater.

- [] No opinion

17. My primary responsibility is

- [] inpatient care.
- [] outpatient care.
- [] other. Please specify _____

18. Were you assigned to the Wright-Patterson Medical Center during March 1975?

- [] Yes
- [] No

Please place your completed questionnaire into the accompanying envelope, seal the envelope, and print the following information on the front of the envelope:

Name
Department or Ward.

LABORATORY STAFF QUESTIONNAIRES

Instructions

1. Complete the first attached questionnaire entitled "Laboratory Staff Questionnaire #1" before completing the second attached questionnaire entitled "Laboratory Staff Questionnaire #2."

2. Indicate your response to each question by placing a mark in the appropriate block.

3. Insert the completed questionnaires into the accompanying envelope, seal the envelope, and print the following information on the front of the envelope:

Name
Section.

This information will be used only to ensure that responses from all laboratory staff at Wright-Patterson Medical Center will be included in the study. The sealed envelope will be opened only by the research team of Analytic Services Inc. (ANSER), and the information you provide will be available only to the team.

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April W-P 1976

LABORATORY STAFF QUESTIONNAIRE #1

	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
1. During my day in the laboratory, I do many different tasks.					
2. There is an opportunity in the laboratory for independent thought and action.					
3. In contrast with workers in industry, laboratory people know the final results of their work.					
4. Supervisors in the laboratory provide valid comments on my performance.					
5. The most important part of my job is helping other people.					
6. Laboratory people get together after work more frequently than do people in other parts of the hospital.					
7. My laboratory assignment permits me to do many different test procedures.					
8. My supervisor leaves me pretty much alone to perform my work in the laboratory.					
9. I know how well I am performing my job each day.					
10. Dealing with other people in the laboratory is an important part of my job.					
11. The laboratory is a great place to develop close friends.					
12. My laboratory assignment permits me to use many different kinds of equipment.					
13. Supervisors in the laboratory provide frequent comments on my performance.					
14. Dealing with people outside the laboratory is an important part of my job.					
15. I perform tasks in the laboratory that are important but outside of my technical specialty.					
16. During a day in the laboratory, I use many different pieces of equipment.					
17. I am responsible for doing complete test procedures in the laboratory.					
18. While on duty, there is almost always an opportunity to talk with laboratory people about nonlaboratory subjects.					
19. When I am on duty, the order in which I perform my tasks, except STATs, is left up to me.					
20. Automated equipment in the laboratory does not interfere with my decisions about the tasks I perform.					
21. When I complete a laboratory test procedure, I consider it a result of my own efforts.					
22. When I start a test procedure, I know that I will have the opportunity to see it through to the end and know the result.					
23. Supervisors often get together with laboratory people after duty hours.					

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LABORATORY STAFF QUESTIONNAIRE #2

1. The normal work week in this laboratory is

- ☐ less than 35 hours.
- ☐ 35-40 hours.
- ☐ 40-45 hours.
- ☐ 45-50 hours.
- ☐ over 50 hours.

2. During the past week, I worked in the laboratory

- ☐ less than 35 hours.
- ☐ 35-40 hours.
- ☐ 40-45 hours.
- ☐ 45-50 hours.
- ☐ over 50 hours.

3. During the past week, I spent

- ☐ 2 hours or less
- ☐ 2-5 hours
- ☐ 5-8 hours
- ☐ 8-11 hours
- ☐ over 12 hours

} on military duties outside the laboratory.

- ☐ I have no military duties outside the laboratory.

4. During the past week, I was on pass or leave

- ☐ no
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5

} days.

5. During the past week, I worked

- ☐ less than 1
- ☐ 1-3
- ☐ 3-6
- ☐ 6-10
- ☐ over 10

} more hours than the normal work week in the laboratory.

6. In performing my tasks in the laboratory, I feel that I have

- ☐ much more than
- ☐ more than
- ☐ all of
- ☐ somewhat less than
- ☐ much less than

} the time that I need to accomplish my tasks.

7. In performing my tasks in the laboratory, I feel that I have

- ☐ much more
- ☐ more
- ☐ about the same amount of
- ☐ less
- ☐ much less

} time than (that) I would expect for a laboratory of this type.

8. When performing my tasks in the laboratory, I am rushed

- ☐ rarely.
- ☐ occasionally.
- ☐ moderately often.
- ☐ often.
- ☐ very often.

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9. When performing my tasks in the laboratory, I am rushed

- ☐ much less often than
- ☐ less often than
- ☐ about as often as
- ☐ more often than
- ☐ much more often than

} I would expect in a clinical laboratory of this kind.

- ☐ No opinion

10. The quality of reports in this laboratory is

- ☐ far superior to
- ☐ slightly superior to
- ☐ about the same quality as
- ☐ slightly inferior to
- ☐ far inferior to

} reports for similar laboratories.

- ☐ No opinion

11. The time available for quality control in this laboratory is

- ☐ more than is needed.
- ☐ all that is needed.
- ☐ almost all that is needed.
- ☐ slightly less than is needed.
- ☐ much less than is needed.
- ☐ Quality control is not part of my job.

12. In laboratories such as this, there is typically

- ☐ more than enough time
- ☐ all the time that is needed
- ☐ almost as much time as is needed
- ☐ *less time than is needed*
- ☐ much less time than is needed

} for quality control.

- ☐ No opinion

13. Please give your rank _____

14. Please give AFSC number _____

15. Are you a student?

- ☐ Yes
- ☐ No

16. Were you assigned to the Department of Pathology at the Wright-Patterson Medical Center during March 1975?

- [] Yes
- [] No

Please place your completed questionnaires into the accompanying envelope, seal the envelope, and print the following information on the front of the envelope:

Name
Section.

anser analytic services inc.
5613 LEESBURG PIKE FALLS CHURCH VIRGINIA 22041 (703) 820-2830

3 March 1976

LABORATORY PATIENT QUESTIONNAIRE

Analytic Services Inc. (ANSER), a research organization located in Falls Church, Virginia, is conducting a scientific study of Air Force laboratories. An important part of the study is to find how people like you who use the laboratory feel about the laboratory and its people.

Your conscientious completion of the attached questionnaire will be a major contribution to the scientific study of the laboratory.

Your individual response to the questionnaire will be known only to ANSER's staff.

When you complete the form, seal it in the enclosed envelope and return it to the person who gave it to you or to the receptionist.

Thank you for your valuable help in this important study.

Richard Brooks, Ph.D.
Project Director

	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
1. High caliber people work in the clinical laboratory at the Wright-Patterson Medical Center.					
2. I never have to wait a long time in line at the clinical laboratory at the Wright-Patterson Medical Center.					
3. I would prefer to use the clinical laboratory at the Wright-Patterson Medical Center rather than any other clinical laboratory.					
4. The clinical laboratory people seem happy to work here.					
5. I can completely depend upon the clinical laboratory people each time I come here.					
6. The atmosphere of the clinical laboratory is warm and friendly.					
7. I like to see the same clinical laboratory people each time I come here.					
8. It seems that the clinical laboratory people help each other when the laboratory is busy.					
9. The clinical laboratory people do everything possible to provide the best possible service.					
10. I am never annoyed by the way I am treated by the clinical laboratory people at the Wright-Patterson Medical Center.					
11. The clinical laboratory people treat all who come to the laboratory as equals.					
12. The clinical laboratory people treat me as an individual, not just as another patient number.					
13. The doctor always gets my test results that are needed and gets them when they are needed.					
14. The people in the clinical laboratory always tell me what they are going to do before they do it.					
15. There is no better clinical laboratory than the clinical laboratory at the Wright-Patterson Medical Center.					
16. Are you currently an inpatient at the Wright-Patterson Medical Center?	☐ Yes ☐ No				

APPENDIX F

DATA COLLECTION FORMS

This appendix is a compilation of all data collection forms that were used in the evaluation of AFCLAS at MCWP.

List of Forms

Form 1: Record of Telephone Calls to Wright-Patterson Clinical Laboratory Reception Area

Form 2: Followup for Calls Made from Laboratory Sections at Wright-Patterson AFB

Form 3: Record of Telephone Calls (to be Completed by Laboratory Personnel)

Form 4: Record of Telephone Calls to Malcolm Grow Clinical Laboratory Reception Area

Form 5: Record of Telephone Calls (to be Completed by Reception Area Personnel)

Form 6: Daily Workload Record

Form 7: Request Slip Record

Form 8: *Stat* Request Slip Record

Form 9: Reception Area Observation Record (Errors in Arriving-Outpatient Request Slips)

Form 10: Reception Area Observation Record (Service Time at the Laboratory Reception Desk)

Form 11: Time In/Time Out Card

Form 12: Record of Return from Specimen Collection/ Departure for Result Slip Distribution

Form 13: Record of Tests Sent Out to (Received from) Other Clinical Laboratories

Form 14: Report of Outpatient Clinic Visits

Form 15: Report of Inpatient Census

Form 16: Turnaround Time

Form 17: Inpatient Reports

Form 18: Outpatient Reports

RECORD OF TELEPHONE CALLS TO WRIGHT-PATTERSON CLINICAL LABORATORY RECEPTION AREA

Observation Number _____ Date _____ Time: From _____ To _____ Prepared by _____

Call No.	Extension No. ___			Extension No. ___			Extension No. ___			Extension No. ___			Extension No. ___			Type of Call	Caller		Dispos.	Rec'd. By
	Recept.	Hold	Lab	Recept.	Hold	Lab	Recept.	Hold	Lab	Recept.	Hold	Lab	Recept.	Hold	Lab		Cat.	Loc.		

NOTES

Type of Call: Inquiry (I), Noninquiry (NI), Call originating in lab (O)
Category of Caller: MD, Nurse (N), Other hospital staff (HS), Patient (P), Other (O)
Location of Caller: Specific ward or clinic, outside (O)
Disposition: completed at reception area (C), receptionist will call back (CB), referred to lab section — (identify section)
Received By: Receptionist (R), Laboratory Technician (LT)

FOLLOWUP FOR CALLS MADE FROM LABORATORY SECTIONS AT WRIGHT-PATTERSON AFB

Date _____ Associated with Form 1 Observation Time: From _____ To _____ Prepared by _____

Response Call	Duration of Call		Estimated Time to Retrieve Information (minutes)	Category of Caller and Location	Person Called		Comments
	Measured	Lab Sec. Log			Location Called	Category	

NOTES

Response Call: Yes (Y), No (N)
Location Called: Name of ward or clinic
Category of Caller: Lab Officer (LO), Lab Section Supervisor (S), Lab Technician (LT)

RECORD OF TELEPHONE CALLS*
(To be completed by Laboratory Personnel)

Laboratory Section or Office _____ Date _____

Time of Call	Calls Received by Laboratory Personnel		Calls Placed by Laboratory Personnel		
	Inquiry	Other	Report Stat Result	Call in Resp. to Prev. Inq.	Other
0730-0830					
0830-0930					
0930-1030					
1030-1130					
1130-1230					
1230-1330					
1330-1430					
1430-1530					
1530-1630					
1630-1730					
Calls Outside Normal Duty Hours of 0730 to 1730					

Visits for Information on Test Status or Test Results

Time of Visit	Categ. of Visit	Estimated Time to Retrieve Information (minutes)

Record of Inquiry Response Calls*

Time of Call	Duration of Call (minutes)	Estimated Time to Retrieve Information (minutes)	Name of Person Placing Call	Person Called	
				Location Called	Category

*For all telephone calls placed by laboratory personnel in response to a previous inquiry, please complete the section entitled "Record of Inquiry Response Calls."

For all visits for information on test status or test results, please complete the section entitled "Visits for information on Test Status or Test Results."

NOTES

Inquiry Call: Any telephone request for test status or test results Location Called: Name of specific ward or clinic Category of Person Called: MD, Nurse (N), Other hospital staff (HS)

RECORD OF TELEPHONE CALLS TO MALCOLM GROW CLINICAL LABORATORY RECEPTION AREA

Observation Number _____ Date _____ Time: From _____ To _____ Prepared by _____

Calls Received at Reception Area							Response Calls from Lab Sections					
Call No.	Duration of Call	Type of Call	Caller		Disposition	Received By	Duration	Estimated Time to Retrieve Information	Caller		Person Called	
			Category	Location					Categ.	Locat.	Location Called	Category

NOTES

Type of Call: Inquiry (I), Noninquiry (NI)
Category of Caller: MD, Nurse (N), Other Hospital Staff (HS), Patient (P), Other (O)
Location of Caller: Specific ward or clinic or outside (O)
Disposition: Completed at reception area (C), Receptionist Call Back (CB), Referred to Lab Section — (identify section)
Received By: Receptionist (R), Laboratory Technician (LT)
Category of Caller for Response Call: Lab Officer (LO), Lab Section Supervisor (S), Lab Technician (LT)

RECORD OF TELEPHONE CALLS
(to be completed by Reception Area Personnel)

Prepared by _____ Date _____

Hour	Total Calls Received at Reception Area		Record of Calls Transferred																			
			Stat. Lab		Chem.		Central Proc.		Hem.		Coag.		Urin.		Micro.		Blood Bank		Histo.		Other	
	Inquiries	Other	Inq.	Oth.	Inq.	Oth.	Inq.	Oth.	Inq.	Oth.	Inq.	Oth.	Inq.	Oth.	Inq.	Oth.	Inq.	Oth.	Inq.	Oth.	Inq.	Oth.
0730–0830																						
0830–0930																						
0930–1030																						
1030–1130																						
1130–1230																						
1230–1330																						
1330–1430																						
1430–1530																						
1530–1630																						
Totals																						

Page____ of____ Pages

DAILY WORKLOAD RECORD

Lab Section _____ Date _____ Prepared by _____

	Routine		Stat		Total
	In	Out	In	Out	

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REQUEST SLIP RECORD

Prepared by _____ Date _____

Standard Slips by Laboratory Section	Date																					
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Stat Lab																						
Chemistry																						
Hematology																						
Special Hematology																						
Urinalysis																						
Microbiology																						
Parasitology																						
Serology																						
Histopathology																						
Other Slips (list)																						

STAT REQUEST SLIP RECORD

Prepared by _____ Date _____

Date	Hematology		Urinalysis		Stat Lab	
	In	Out	In	Out	In	Out

RECEPTION AREA OBSERVATION RECORD
(Errors in Arriving-Outpatient Request Slips)

Observation Number _____ Time: From _____ To _____

Date _____ Observer _____

Slips Observed	Patient's Initials	Errors								
		Patient's Name	SSAN	Clinic/ Ward	Telephone No.	Physician	Rank/ Relation	Date	Other	Comments
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										

NOTES

Identify Error: Missing (M), Illegible (IL), Incomplete (SSAN only) (IC)

RECEPTION AREA OBSERVATION RECORD
(Service Time at the Laboratory Reception Desk)

Observation Number _____ Date _____ Time: From _____ To _____ Observer _____

Patients Observed	Time of Arrival	Service Time	Type of Patient	Instructions Given	Comments
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

NOTES

Type of Patient: In (I), Out (O)
Instructions Given by Receptionist: Yes (Y), No (N)

TIME IN

The time that patients spend in the clinical laboratory is being studied and your cooperation is needed. Please return this card to the receptionist or the person who gave it to you when you leave the laboratory.

Are you here for a Glucose Test? □ Yes
□ No

TIME OUT

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FORM 11

Page ____ of ____ Pages

RECORD OF: ☐ RETURN FROM SPECIMEN COLLECTION
☐ DEPARTURE FOR RESULT SLIP DISTRIBUTION

Location _____ Date _____ Certified by _____

Name	Time	Location*

*Specimen collection teams enter collection location; result distribution personnel enter destination of laboratory reports to be delivered.

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RECORD OF TESTS ☐ SENT OUT TO ☐ RECEIVED FROM } OTHER CLINICAL LABORATORIES

Date: From_____ To_____ Prepared by_____ Date_____

Test	Facility							

REPORT OF OUTPATIENT CLINIC VISITS

Clinic _____ Prepared by _____ Date _____

Week of	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday

REPORT OF INPATIENT CENSUS

Prepared by _____ Date _____

Ward	Date								
Total Census									
Admissions									
Discharges									

TURNAROUND TIME*

Date of Sample_____ Prepared by _____

Sample Size _____ Date _____

Name	SSAN	Type of Patient	Type of Request Slip	Date/Time In	Date/Time to Dist. Pt.	Date Found at Record Location	Cannot Be Filed	Comments

*This form will only be used if laboratory reports cannot be Xeroxed.

Page ____ of ____ Pages

Prepared by _____

INPATIENT REPORTS

Ward _____

Name	Identification Number	Location							Comments
		Laboratory Out Box	Ward In Basket	Physicians Box	Patient Record	Patient Discharged	Report Signed	Flow Sheet	

AD-A043 665 ANALYTIC SERVICES INC FALLS CHURCH VA F/G 6/5
EVALUATION OF THE AIR FORCE CLINICAL LABORATORY AUTOMATION SYST--ETC(U)
MAY 77 R C BROOKS, I J CASEY, P W BLACKMON F49620-77-C-0025
UNCLASSIFIED ANSER-HSDN-77-5 NL

4 OF 4
AD A043665

END
DATE FILMED
9-77
DDC

Page ____ of ____ Pages

Prepared by _____

OUTPATIENT REPORTS

Name	SSAN	Sample Number	Record Search				Record Search				Date Slip Found in Record
			Location	Date of Search	Record Found	Comments	Location	Date of Search	Record Found	Comments	

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FORM 18

APPENDIX G

SUMMARY OF HYPOTHESES

This appendix summarizes the 58 hypotheses that served as the basis for the AFCLAS evaluation. Also included is a reference to the appropriate section in this Volume II where additional details on the results of the evaluation with respect to a given hypothesis may be found.

1. Time spent producing administrative reports will change, for an equal number and distribution of test requests.

The computation of the net cost of AFCLAS included a cost for the change in laboratory personnel time for producing administrative reports. The computation of net personnel time is reported in Table III-2, task 1.

2. The number of telephone inquiries to the laboratory central site (the reception desk or central computer site) will change, for an equal number and distribution of test requests and an equal number of telephone lines and personnel at the central site.

In Chapter II, Section A, we present the results of the statistical analysis of the frequency of telephone inquiries. Computation of the net cost of AFCLAS included a cost for the change in laboratory personnel time required for telephone inquiries (Table III-2, task 25). Calls to the central computer site were not included in the analysis because all telephone inquiries were processed through the reception area in both period X and period Y.

3. Time spent responding to telephone inquiries received by the laboratory central site will change, for an equal number and distribution of test requests and an equal number of telephone lines and personnel at the central site.

The computation of the net cost of AFCLAS included a cost for the change in laboratory personnel time spent responding (retrieving information) to telephone inquiries. The computation of net personnel time is reported in Table III-2, tasks 25 and 26.

4. Time spent on the telephone for inquiries to the laboratory by personnel both inside and outside the laboratory will change, for an equal number and distribution of test requests and an equal number of telephone lines and personnel at the central site.

In Chapter II, Section B, we present the results of the statistical analysis of the duration of telephone inquiries. The computation of the net cost of AFCLAS included a cost for the change in personnel time, both inside and outside the laboratory, spent on the telephone for inquiries by other personnel inside and outside the laboratory. The computation of net personnel time is reported in Table III-2, task 25.

5. The distribution by location and type of caller of telephone inquiries to the laboratory central site will change, for an equal number and distribution of test requests and for an equal number of telephone lines and personnel at the central site.

We encountered difficulty in collecting reliable data to test this hypothesis. Therefore, we did not perform extensive analysis or report any results relating to this hypothesis.

6. Time required for filing laboratory clinical forms in laboratory files will change, for an equal number and distribution of test requests.

The computation of the net cost of AFCLAS included a cost for the change in laboratory personnel time for filing clinical forms in laboratory files. The computation of net personnel time is reported in Table III-2, tasks 2 through 6.

7. Time required to file laboratory reports in outpatient medical records will change, for an equal number and distribution of test requests.

The computation of the net cost of AFCLAS included a cost for the change in personnel time for filing laboratory reports in outpatient medical records. The computation of net personnel time is reported in Table III-2, task 7.

8. Time required to file laboratory reports at the nursing stations will change, for an equal number and distribution of test requests.

The computation of the net cost of AFCLAS included a cost for the change in personnel time for filing laboratory reports at nursing stations. The computation of net personnel time is reported in Table III-2, task 8.

9. Time required for preparing laboratory clinical forms will change, for an equal number and distribution of test requests.

The computation of the net cost of AFCLAS included a cost for the change in laboratory personnel time for preparing laboratory clinical forms. The computation of net personnel time is reported in Table III-2, tasks 10 through 15.

10. Time spent compiling College of American Pathologists (CAP) standard workload figures will change, for an equal number and distribution of test requests.

The computation of the net cost of AFCLAS included a cost for the change in laboratory personnel time for compiling CAP standard workload figures. The computation of net personnel time is reported in Table III-2, task 1.

11. Time required for labeling specimens will change, for an equal number and distribution of test requests.

The computation of the net cost of AFCLAS included a cost for the change in laboratory personnel time for labeling specimens. The computation of net personnel time is reported in Table III-2, tasks 16 and 28.

12. Time required for preparing lists for specimen collection will change, for an equal number and distribution of test requests.

The computation of the net cost of AFCLAS included a cost for the change in laboratory personnel time for preparing lists for specimen collection. The computation of net personnel time is reported in Table III-2, task 17.

13. Time required for recording results of tests that will be online with AFCLAS will change, for an equal number and distribution of test requests.

The computation of the net costs of AFCLAS included a cost for the change in laboratory personnel time for recording results of tests that will be online with AFCLAS. The computation of net personnel time is reported in Table III-2, tasks 12 through 15.

14. Time required for recording results of tests that will be offline with AFCLAS will change, for an equal number and distribution of test requests.

The computation of the net cost of AFCLAS included a cost for the change in laboratory personnel time for recording results of tests that will be offline with AFCLAS. The computation of net personnel time is reported in Tables III-2, tasks 12 through 15 and 28.

15. Time required for entering laboratory requests by mark-sense card will change, for an equal number and distribution of test requests.

The steps involved and the overall accomplishment time for this hypothesis are reported in Appendix C. The total time to perform the task associated with this hypothesis is included in the additional reception-personnel time reported in Chapter IV.

16. Time required for keyboard entry of patient name and identification at the laboratory reception desk will change, for an equal number and distribution of test requests.

The total time to perform the task associated with this hypothesis is included in the additional reception-personnel time reported in Chapter IV.

17. Time required for keyboard entry of patient name and identification in the registrar's office will change, for an equal number and distribution of test requests.

Since the registrar's office does not have an AFCLAS terminal, the task associated with this hypothesis was not performed.

18. Time required for entering laboratory test results by mark-sense card will change, for an equal number and distribution of test requests.

The computation of the net cost of AFCLAS included a cost for the change in laboratory personnel time for entering laboratory test results by mark-sense card. The computation of net personnel time is reported in Table III-2, task 12.

19. Time required for keyboard entry of free-text laboratory test results will change, for an equal number and distribution of test requests.

The computation of the net cost of AFCLAS included a cost for the change in laboratory personnel time for keyboard entry of free-text laboratory test results. The computation of net personnel time is reported in Table III-2, task 12.

20. Time required for supervisor's review and certification of results and worksheets will change, for an equal number and distribution of test requests.

The computation of the net cost of AFCLAS included a cost for the change in laboratory personnel time for supervisor's review and certification of results. The computation of net personnel time is reported in Table III-2, task 18.

21. Time required for technician's review and certification of results and worksheets will change, for an equal number and distribution of test requests.

The computation of the net cost of AFCLAS included a cost for the change in laboratory personnel time for technician's review and certification of results and worksheets. The computation of net personnel time is reported in Table III-2, task 18.

22. Time spent on statistical analysis for quality control will change, for an equal number and distribution of test requests.

The computation of the net cost of AFCLAS included a cost for the change in laboratory personnel time for statistical analysis for quality control results. The computation of net personnel time is reported in Table III-2, task 19.

23. The number of times statistical analyses of quality control sample results are performed will change, for an equal number and distribution of test requests.

As observed by MET personnel, AFCLAS did not affect the frequency with which laboratory personnel performed statistical analyses of quality control samples. Therefore, the task associated with this hypothesis was not analyzed in detail. MET observations are reported in Table III-2, task 19.

24. The kinds of statistical analyses of quality control sample results will change, for an equal number and distribution of test requests.

As observed by the MET personnel, AFCLAS did not affect the kinds of statistical analyses performed by laboratory personnel. Therefore, the task associated with this hypothesis was not analyzed in detail. MET observations are reported in Table III-2, task 19.

25. The number and kinds of statistical analyses of patient results by population will change, for an equal number and distribution of test requests.

There was no evidence that statistical analysis of patient results by population was performed during either period X or period Y. MET observations are reported in Table III-2, task 20.

26. The time required for statistical analyses of patient results by population will change, for an equal number and distribution of test requests.

There was no evidence that statistical analysis of patient results by population was performed during either period X or period Y. Therefore, the time was zero for each period. MET observations are reported in Table III-2, task 2.

27. Time spent on calculations and/or conversions from raw to clinical values for test reports will change, for an equal number and distribution of test requests.

AFCLAS did not change the methods by which laboratory technicians performed calculations and/or conversions. The activities observed are described in Appendix B and Table III-2, task 21.

28. Time spent on operation of the computer by the laboratory staff will change.

The computation of the net cost of AFCLAS included a cost for the change in laboratory personnel time for operation of both the CREATE computer system and the AFCLAS computer system. The computation of net personnel time is reported in Table III-2, task 22, and in Chapter IV.

29. Kinds and numbers of laboratory clinical forms used will change, for an equal number and distribution of test requests.

The net cost of laboratory clinical forms and computer supplies is reported in Chapter V.

30. Kinds and numbers of tests sent out to other laboratories for processing will change, for an equal number and distribution of test requests.

There is no indication that AFCLAS changed the number of tests sent out to other laboratories for processing. Hence, the data on tests shipped is not reported.

31. Kinds and numbers of tests sent to the laboratory being studied by other laboratories will change, for an equal number and distribution of test requests at the laboratories sending the test requests.

Based on observation by the MET, AFCLAS did not appear to change the number of tests sent to the MCWP clinical laboratory by other clinical laboratories for processing. Hence, data on tests sent to the MCWP clinical laboratory are not reported. The tests sent to the MCWP laboratory are included in the workload figures and hence in the computations for net personnel times that utilized test workload figures.

32. The number of *stat* requests will change, for an equal number and distribution of test requests.

Based on observation by the MET, intervening factors within the clinical laboratory appeared to have a greater impact on the number of *stat* requests ordered than did the introduction of AFCLAS. Hence, the number of *stat* requests ordered was not analyzed in detail.

33. Time that laboratory staff members work in addition to normal duty hours will change, for an equal number and distribution of test requests, and an equal number of laboratory staff.

We investigated the time that laboratory staff members work in addition to normal duty hours by analyzing responses to questions on the Laboratory Staff Questionnaire Number 2. The results of the investigation are presented in Chapter VI, Section C.

34. Usability of laboratory reports to physicians will change.

We investigated the usability of laboratory reports by analyzing responses to questions on the Physician Questionnaire and by analyzing information obtained during physician interviews. The results of the investigations are presented in Chapter VI, Section A.

35. Time to provide patient service at the laboratory reception desk will change, for an equal number and distribution of test requests.

In Chapter II, Section C, we present the results of the statistical analysis of patient service time at the laboratory reception desk.

36. This hypothesis was dropped prior to period X.

37. Time the patient spends at the laboratory will change, for an equal number and distribution of test requests.

In Chapter II, Section D, we present the results of the statistical analysis of laboratory service time for patients. Computation of the change in service time is also reported in Table III-2, task 30.

38. Patient satisfaction with the laboratory will change.

Patient satisfaction with the laboratory, as measured by scores on the Laboratory Patient Questionnaire, is reported in Chapter VI, Section D.

39. Physician acceptance of the laboratory will change.

Physician acceptance of the laboratory as measured by scores on the Physician Questionnaire is reported in Chapter VI, Section A.

40. Laboratory staff satisfaction will change.

Laboratory staff satisfaction, as measured by scores on the Laboratory Staff Questionnaire Number 1, is reported in Chapter VI, Section C.

41. Admissions and Dispositions Department staff acceptance of the laboratory will change.

We determined Admissions and Dispositions Department staff acceptance by analyzing information obtained during interviews. The results of the analysis of the interview data are reported in Chapter VI, Section F.

42. Medical Records Department staff acceptance of the laboratory will change.

We determined Medical Records Department staff acceptance by analyzing information obtained during interviews. The results of the analysis of the interview data are reported in Chapter VI, Section E.

43. Registered nurses' acceptance of the laboratory will change.

Registered nurses' acceptance of the laboratory, as measured by scores on the Registered Nursing Staff Questionnaire, is reported in Chapter VI, Section B.

44. The number of transcription errors will change, for an equal number and distribution of test requests.

We were not able to collect the data necessary for investigating this hypothesis.

45. Completeness of the medical record will change.

In Chapter II, Section E, we present the results of the statistical analysis of completeness of the medical record.

46. Turnaround time will change, for an equal number and distribution of test requests.

In Chapter II, Section F, we present the results of the statistical analysis of turnaround time.

47. Quality of patient care will change.

We investigated patient care by analyzing responses to questions on the Physician Questionnaire and by analyzing information obtained during physician interviews. The results of the investigation are presented in Chapter VI, Section A, and in Chapter VII.

48. Numbers and kinds of reports produced will change.

A list of reports is contained in Appendix C.

49. Numbers and kinds of tests requested by physicians for outpatients will change, for an equal number of outpatient visits, for the same distribution of utilization by outpatient departments.

The number of tests, by kind of test, for period X and period Y are reported in Appendix B, Table B-21. In period X the data is divided by number of inpatient tests and number of outpatient tests, but in period Y we were only able to collect total number of tests requested.

50. Numbers and kinds of tests requested by physicians for inpatients will change, for an equal number of total hospital inpatient days, for the same distribution of patients by inpatient category.

The number of tests by kind of test for period X and period Y are reported in Appendix B, Table B-21. In period X the data is divided by number of inpatient tests and number of outpatient tests, but in period Y we were only able to collect total number of tests requested.

51. Time required to complete laboratory test request slips outside the laboratory will change, for an equal number and distribution of test requests.

The computation of the net cost of AFCLAS included a cost for the change in personnel time for completing laboratory test request slips outside the laboratory. The computation of net personnel time is reported in Table III-2, task 10.

52. The numbers of improperly completed outpatient test request slips arriving at the reception desk will change, for an equal number and distribution of test requests.

In Chapter II, Section G, we present the results of the statistical analysis of the number of improperly completed outpatient test request slips arriving at the laboratory reception desk.

53. Time required by supervisors (laboratory officers) to respond to inquiries, complaints, errors detected before test results are reported, and errors in test results reported to physicians will change, for an equal number and distribution of test requests.

The computation of the net cost of AFCLAS included a cost for the change in laboratory personnel time supervisors spend in responding to inquiries. The computation of net personnel time is reported in Table III-2, task 24.

54. Time between distribution and filing of laboratory reports will change.

In Chapter II, Section E, we present the data for the time between distribution and filing of laboratory reports.

55. Time required for completing cumulative laboratory reports (equivalent to flow sheets of laboratory results) will change.

The computation of the net cost of AFCLAS included a cost for the change in laboratory personnel time to complete cumulative laboratory reports. The computation of net personnel time is reported in Table III-2, task 9.

56. Time required to report *stat* results by telephone will change, for an equal number and distribution of test requests.

The computation of the net cost of AFCLAS included a cost for the change in laboratory personnel time required to report *stat* results by telephone. The computation of net personnel time is reported in Table III-2, task 23.

57. Time required for preparing a list for the laboratory of admissions, discharges, and interward transfers will change, for an equal number and distribution of test requests.

The computation of the net cost of AFCLAS included a cost for the change in personnel time for preparing a list for the laboratory of admissions, discharges, and interward transfers. The computation of net personnel time is reported in Table III-2, task 29.

58. Time required for reviewing new AFCLAS-generated reports will change, for an equal number and distribution of test requests.

The computation of the net cost of AFCLAS included a cost for the change in laboratory personnel time for reviewing new AFCLAS-generated reports. The computation of net personnel time is reported in Table III-2, task 27.

APPENDIX H

TOTAL YEARLY COST OF ELECTRICITY

The total cost of electricity for operating the computer equipment inside the computer room, the peripheral equipment outside the computer room, and the air-conditioning equipment is derived in this appendix.

A. Power Requirements and Heat Output for Computer Equipment and Peripherals

Data in this section was obtained from hardware personnel at the vendor's home office and from the system site preparation manual. The total AFCLAS system requirement for equipment inside the computer room is 18.4 kilovolt-amperes (kVA) and 43,000 British thermal units (Btu) per hour (hr). This represents a moderate operating condition--disks seeking, line printer printing, and tape units operational. The numbers reflected an average (on the high side).

Peripheral equipment outside the computer room has the following power requirements:

Cathode Ray Tube (CRT) (Model VIP 7705)	1/2 kVA	1,500 Btu per hr
Mark Document Reader (MDR)	1/4 kVA	400 Btu per hr
T300	1/4 kVA	400 Btu per hr
T1200	1/4 kVA	400 Btu per hr
Teletypes	1/4 kVA	375 Btu per hr

Total power requirements for peripheral equipment are as follows:

CRT	10 units	5 kVA	15,000 Btu per hr
MDR	8 units	2 kVA	3,200 Btu per hr
T300	7 units	1.75 kVA	2,800 Btu per hr
T1200	3 units	.75 kVA	1,200 Btu per hr
Teletypes	3 units	.75 kVA	1,125 Btu per hr
		10.25 kVA	23,325 Btu per hr

Electricity was figured at $.0205 per kilowatt (kW) (estimate) obtained from base engineering at Wright-Patterson AFB). There are 8,760 hrs in a year for 24 hr per day, 7 days per week operation.

The requirement of 43,000 Btu per hr is adjusted in a later discussion because some equipment is not operated 24 hours a day.

The following conversion factor is used throughout:

1 kVA = 3,413 Btu per hr.

Therefore,

28.65 kVA = 97,782 Btu per hr.
66,325 Btu per hr = 19.43 kVA.

Note that 97,782 Btu per hr is greater than 66,325 Btu per hr if all power is converted to heat and it is assumed that a power factor of 1.0 for kVA is not compatible with Btu per hr. Discussion with the vendor's hardware personnel indicates that the kVA requirement is probably high to accommodate the starting of transients such as motors. The specified heat output (Btu per hr) is probably a more accurate measurement of the steady-state condition. Computations of cost will use Btu per hr for both electrical load and air-conditioning load.

1. Computer Room Equipment

Assume tape drives are operating only 2 hours per day and all other equipment is operating 24 hours per day. Two tape drives at 5,100 Btu per hour each is 10,200 Btu per hr.

32,800 Btu per hr for all equipment except tape drives
+ 850 Average Btu per hr for tape drives, i.e., $\left(\frac{10{,}200 \text{ Btu per hr} \times 2 \text{ hr}}{24 \text{ hr per day}}\right)$
33,650 Btu per hr is average load for 24 hr.

Total equipment in computer room	18.4 kVA	43,000 Btu per hr
Total equipment outside computer room	10.25 kVA	23,325 Btu per hr
	28.65 kVA	66,325 Btu per hr

$$\left(\frac{33{,}650 \text{ Btu}}{\text{hr}}\right)\left(\frac{1 \text{ kW}}{3{,}413 \text{ Btu}}\right)\left(\frac{8{,}760 \text{ hrs}}{\text{year}}\right)\left(\frac{\$.0205}{\text{kW}}\right) =$$

$1,771 per year for equipment inside computer room.

2. Peripheral Equipment Outside Computer Room

The average load for 24 hours for peripheral equipment outside the computer room is 23,400 Btu per hr. There are 2,920 hrs in a year based on 8 hr per day operation, 7 days per week.

$$\left(\frac{23{,}400 \text{ Btu}}{\text{hr}}\right)\left(\frac{1 \text{ kW}}{3{,}413 \text{ Btu}}\right)\left(\frac{2{,}920 \text{ hrs}}{\text{year}}\right)\left(\frac{\$.0205}{\text{kW}}\right) =$$

$410 per year for peripheral equipment outside the computer room.

B. Power Requirements for Air-Conditioning Equipment

The air-conditioning system for the MCWP computer room has the following specifications:

Model DA8 Serial AE 4 3753
90,000 Btu
Volts (V) 208
Phase 3
Maximum Amperes
Fan 5,100 CFM
Two compressors of 45,000 Btu each.

The power consumption of the components is as follows:

Two compressors	20 A each
Two stages reheat (both on together)	14.1 A each
Two stages humidification (both on together)	7.8 A each
One blower motor at 3 horsepower	10.8 A

The blower dissipates 7,700 Btu per hour which also must be removed from the computer room.

Average heating load in computer room	33,650 Btu per hr
Heating load due to blower motor	7,700 Btu per hr
	41,350 Btu per hr

Note: The power requirements of the compressor do not vary significantly with outside ambient temperature. During hot weather there are additional small blowers running, which cool the coils. The power consumption of these small blower motors was ignored.

We assumed the following to be the average operating conditions:

Blower	24 hr per day 7 days per week
Compressor	24 hr per day 7 days per week
Humidification without heating	1/2 hr per day 7 days per week
Dehumidification with heating	--insignificant

We converted the average operating conditions to power consumption as follows:

Blower	10.8 A at 208 V, 8,760 hr per year	19,678 kilowatt-hours (kWh) per year
Compressor	20 A at 208 V, 8,760 hr per year	36,441 kWh per year
Humidifiers	15.6 A at 208 V, 365 hr per year	1,184 kWh per year
		57,303 kWh per year

At $0.0205 per kWh, this is $1,175 per year.

The total yearly cost of electricity for operating the computer equipment inside the computer room, the peripheral equipment outside the computer room, and the air-conditioning equipment is as follows:

Computer equipment inside the computer room	$1,771
Peripheral equipment outside the computer room	410
Air-conditioning equipment	1,175
	$3,356

APPENDIX I

NONDOLLAR BENEFITS AS ASSESSED FROM PHYSICIAN QUESTIONNAIRES

In this appendix each of the nondollar benefits is listed along with the questions in the Physician Questionnaire Part 2 that measure the impact of AFCLAS on that benefit. We used the percentages shown in Table VI-10 to determine whether the data indicated that the nondollar category improved or deteriorated with the installation of AFCLAS.

Each of the nondollar benefits is listed below.

- Patient Care

Question 1	Unfavorable
Question 8	Unfavorable
Question 9	Unfavorable
Question 10	Favorable
Question 13	Unfavorable
Question 14	Unfavorable
Question 17	Favorable
	Overall Deterioration*

- Cumulative Reports

Question 30	Favorable
	Overall Improvement

- Lost Reports

Question 22	Unfavorable
Question 31	Favorable
	Overall Deterioration

- Legibility of Reports

Question 24	Favorable
Question 25	Favorable
	Overall Improvement

- Turnaround Time for Routine Reports

Question 16	Unfavorable
	Overall Deterioration

* The overall assessments were made based on a subjective weighting of the relative importance of each question.

- Turnaround Time for *Stat* Reports

Question 21	Unfavorable
	Overall Deterioration

- Retrieval of Test Results

Question 7	Favorable
Question 19	Unfavorable
Question 20	Favorable
Question 27	Unfavorable
	Overall Improvement

- Report Format

Question 10	Favorable
Question 15	Favorable
Question 18	Favorable
	Overall Improvement

- Accuracy of Test Results

Question 2	Unfavorable
Question 6	Unfavorable
Question 11	Unfavorable
Question 14	Unfavorable
	Overall Deterioration

- Provides More Patient Information

Question 3	Favorable
Question 4	Favorable
	Overall Improvement

As measured by the questionnaire, five of the 10 nondollar categories showed an overall improvement and five showed an overall deterioration.

APPENDIX J

STATISTICAL TESTS

This appendix gives the statistical tests that were used in the analyses of the areas that were presented in Chapter II.

A. F Test Based on Poisson Distribution

In the analysis for Section A of Chapter II, we assumed that the number (x) of inquiry telephone calls received at the reception desk each hour followed a Poisson distribution, i.e.,

$$f(x) = \frac{e^{-\varepsilon}\,\varepsilon^{x}}{x!} \quad , \qquad x = 0,1,2,\ldots$$

where ε = expected number of calls. The Poisson distributional assumption is a common one in analyzing telephone call frequency data [Ref. 1]. We tested the null hypothesis H_o: $\varepsilon_1/T_1 = \varepsilon_2/T_2$ against the alternative hypothesis H_1: $\varepsilon_1/T_1 > \varepsilon_2/T_2$ where

ε_1 = expected number of calls in period X

ε_2 = expected number of calls in period Y

T_1 = number of hours of observation in period X

T_2 = number of hours of observation in period Y.

The test statistic [Ref. 2] that we used is

$$F_A = \frac{x_1}{x_2 + 1} \quad \frac{T_2}{T_1} \quad ,$$

where

x_1 = observed number of calls in period X

x_2 = observed number of calls in period Y.

F_A was compared with the critical points F_{1-P} in tables of the F distribution with $2(x_2 + 1)$ numerator degrees of freedom and $2x_1$ denominator degrees of freedom in order to determine the P values given in Table II-1.

B. F Test Based on Exponential Distribution

In the analysis for Sections B, C, D, and F of Chapter II, we assumed that the length of time (y) under study (inquiry telephone call duration in Section B, reception desk service time in Section C, laboratory service time in Section D, and turnaround time in Section F) followed an exponential distribution, i.e.,

$$f(y) = \theta e^{-\theta y} \quad , \; o<y<\infty$$

where $1/\theta$ = expected length of time. The exponential distributional assumption is a common one in analyzing service time data [Ref. 3]. We tested the null hypothesis H_o: $\theta_1 = \theta_2$ against the alternative hypothesis H_1: $\theta_1 \neq \theta_2$ where

$1/\theta_1$ = expected length of time in period X

$1/\theta_2$ = expected length of time in period Y.

The test statistic that we used is

$$F_B = \overline{y_1} / \overline{y_2} \quad ,$$

where

$\overline{y_1}$ = observed mean length of time in period X

$\overline{y_2}$ = observed mean length of time in period Y.

It can be shown that F_B follows an F distribution under the null hypothesis with $2N_1$ numerator degrees of freedom and $2N_2$ denominator degrees of freedom where

N_1 = number of observations in period X

N_2 = number of observations in period Y.

F_B was compared with the critical points $F_{P/2}$ and $F_{1-P/2}$ in tables of the F distribution with $2N_1$ numerator degrees of freedom and $2N_2$ denominator degrees of freedom in order to determine the P values and significance levels presented in Sections B, C, D, and F.

C. Chi-Squared Test Based on Binomial Distribution

In the analysis for Section E and Section G of Chapter II, we assumed that the number (z) of events under study (the number of laboratory reports that were not filed in the medical record in Section E and the number of laboratory slips that were in error in Section G) followed a binomial distribution, i.e.,

$$f(z) = \binom{n}{z} p^{z} (1-p)^{n-z}, \quad z = 0, 1, 2, \ldots$$

where

n = total number of observations

p = probability of occurrence of event.

Thus, the individual events were assumed to follow a Bernoulli distribution, i.e., occurrence with probability p and non-occurrence with probability 1-p. We tested the null hypothesis H_o: $p_1 = p_2$ against the alternative hypothesis H_1: $p_1 \neq p_2$ where

p_1 = probability of event occurrence in period X

p_2 = probability of event occurrence in period Y.

The test statistic [Ref. 4] that we used is

$$\chi_c^2 = \frac{\left(|n_{11}n_{22} - n_{21}n_{12}| - n/2 \right)^2 n}{n_{.1}\, n_{.2}\, n_{1.}\, n_{2.}}$$

where the data are arranged as follows:

	Observed Number of Occurrences of Event	Observed Number of Nonoccurrences of Event	Total
Period X	n_{11}	n_{12}	$n_{1.}$
Period Y	n_{21}	n_{22}	$n_{2.}$
Total	$n_{.1}$	$n_{.2}$	n

χ_c^2 was compared with the critical points χ_{1-P}^2 in tables of the chi-squared (χ^2) distribution with 1 degree of freedom in order to determine the P values presented in Section E and Section G.

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APPENDIX K

SOME OBSERVATIONS ON LESSONS LEARNED DURING THE EVALUATION OF AFCLAS

SOME OBSERVATIONS ON LESSONS LEARNED DURING THE EVALUATION OF AFCLAS

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A. Introduction

This paper is a summary of my opinions about the most significant lessons learned in the course of the AFCLAS evaluation. Since the AFCLAS evaluation at the USAF Medical Center at Wright-Patterson AFB has been completed, the majority of the observations are made in that context, but those from the ongoing evaluation at the Malcolm Grow USAF Medical Center at Andrews AFB are also included. Since the observations are a byproduct rather than an objective of the evaluation, they have not been completely and thoroughly investigated. While many of the observations are stated in the form of recommendations, in most cases further assessment of their costs and benefits, and sometimes of their feasibility, would be necessary before a firm recommendation could be made.

My observations are offered for consideration before AFCLAS is installed at other facilities. Some of the observations may provide ideas for modifying AFCLAS or laboratory operations at the existing two test sites, and some may be generalized to other medical information systems (MIS).

AFCLAS was a developmental system that was funded and managed as if it were a production system. The primary objective of AFCLAS was to improve the operation and management of the clinical laboratory. Only to a very limited extent did the committee that developed the functional specifications consider the operation and management of the hospital as a whole. Since AFCLAS was specified as a state-of-the-art system not constrained by cost of operation, no systems analysis was conducted to determine and eliminate unnecessary requirements and to match the capabilities of

a laboratory MIS with existing or modified laboratory operational procedures. A systems analysis of AFCLAS at each test site should help to integrate all parts of the current system and to improve laboratory operations.

A systems analysis of laboratory operations may also provide information for significantly improving the manual operations of laboratories in general. Installation of an MIS might be deferred until a more effective and efficient laboratory MIS can be developed and tested, or until an integrated MIS is operational.

Careful analysis should be conducted to determine whether AFCLAS as a system can be modified to make it more effective and efficient. Thorough exploration with the vendor will be required to ascertain if AFCLAS can be improved and how much such improvements would cost. If improvements are justified, it may then be necessary to install one or two additional modified systems to assess whether AFCLAS can achieve a level of cost effectiveness that would warrant full-scale implementation.

In this paper, my observations for improving AFCLAS are listed individually and then discussed. They are grouped as general items, hardware items, and software items. Some of the individual items should decrease costs and some will initially increase costs but should ultimately lead to a later decrease in costs. Others should increase costs but provide nondollar benefits. A few items will increase costs but may be justified as a research and development expenditure to gain a better understanding of hospital, laboratory, or AFCLAS operation.

B. General Items

1. A program for overcoming resistance to change should be part of system design.

DISCUSSION: The evaluation of AFCLAS showed some lack of acceptance of the system by the hospital staff at the time of the evaluation. This phenomenon of resistance to innovation or change, called *cultural lag*, is well documented in the sociological literature. By developing a plan to prepare physicians and the hospital staff for change (the installation of AFCLAS) and incorporating it into the overall system design, acceptance could be increased.

The one-time cost of implementing such a plan should be small. The nondollar benefit of increased acceptance may well outweigh the small cost.

2. The introduction of more than one medical information system into a hospital during the evaluation period increases the problem of measuring acceptance.

DISCUSSION: Two computer systems—AFCLAS and MAMS-R—were installed at the Medical Center, Wright-Patterson AFB (MCWP) during the same time period, making it difficult to measure acceptance of AFCLAS independently of MAMS-R. Ideally, only one MIS subsystem should be installed at a given site during the evaluation period. However, if the specific systems to be installed during the evaluation period are identified prior to the design of the evaluation plans, it may be possible to design questionnaires and an analysis to separate the effects of each system (factor analysis). Members of ANSER's technical staff are currently investigating this problem on a time-available basis.

The cost of such analysis is the time for hospital staff to complete a significantly longer questionnaire and the time to design the questionnaires and perform the analysis of responses.

3. A plan to modify laboratory operation to utilize AFCLAS most effectively should be part of an implementation program.

DISCUSSION: The two test sites received AFCLAS with little preparation for the modifications of the clinical laboratory operation that are needed to utilize most effectively the capabilities of the system.

Such a plan would include the items that are listed below and are later discussed individually.

- Modify the reception function and patient flow (see #4)
- Modify the flow of specimens through the laboratory (see #5)
- Establish computer operator positions that include additional responsibilities (see #6)
- Establish a position of AFCLAS Systems Manager (see #7).

Implementation of such a plan should ultimately reduce cost since personnel should work more effectively and save time.

4. The reception function and patient flow should be reviewed and modified, as necessary.

DISCUSSION: In period X, the reception area was staffed by one full-time receptionist with laboratory technicians manning

the reception desk when the receptionist was not available. The receptionist's primary duties included the following:

- Receiving patients with test request slips and reviewing request slips for completeness
- Instructing patients
- Receiving specimens sent from wards or clinics
- Answering the telephone for all incoming calls and routing them to the appropriate section.

During period Y, the reception area was staffed by three full-time receptionists during the day, and one full-time receptionist during the evening. The laboratory workload in the evening increased between period X and period Y because the Primary Care Clinic began operating during the evening. The receptionist's duties in period Y consisted of all items listed for period X and, in addition, included entering test request cards into the AFCLAS system.

During period Y, the answering of telephone calls by the receptionists interrupted, and thus delayed, the entering and verification of test requests. A possible solution would be to designate one receptionist to answer telephone inquiries and also to locate her some place other than in the reception area. There may be other solutions that should be explored.

The intermingling of request cards accompanying specimens sent to the laboratory and request cards for patients waiting in the reception area delays both processing of patients in the laboratory and processing of *stat* tests sent to the laboratory. A possible solution to this problem is to separate the accession area for specimens sent to the clinical laboratory from that in the reception area for specimens collected at the laboratory

and to provide more space for the former. This should significantly reduce the confusion that now frequently exists in the reception area of MCWP during peak workload periods. Microbiology, although inconveniently located at Wright-Patterson, is one potential location for a separate accession area. Another possible location is the space occupied by one of the offices near the reception area. The receptionist entering request cards for specimens sent to the clinical laboratory could also be the person to answer telephone calls.

An additional part of the modification to be considered for the receptionist positions should be reclassification of the positions to recognize the new functions associated with AFCLAS. This may allow a higher job classification, which would permit obtaining and retaining competent personnel.

The cost of an additional accession area would include any one-time construction cost, plus the lease cost of a Mark Document Reader (MDR) and terminal. The benefits might include reduced report turnaround time and increased effectiveness and efficiency of performance of the reception function. It should not increase personnel cost and, in the long run, may reduce total personnel cost. This change should also reduce patient waiting time and may thus increase patient satisfaction.

5. <u>The flow of specimens into and through the laboratory should be reviewed and modified, as necessary</u>.

DISCUSSION: The need for multiple specimen-accession areas in the clinical laboratory has been discussed in the previous section on the receptionist's function. The flow of specimens

through the laboratory was not greatly changed by AFCLAS since AFCLAS merely automated what had been previously done manually. I believe that an assessment of the flow of specimens through the laboratory would identify bottlenecks, which, if removed, could reduce turnaround time significantly.

Thus, a study is needed to analyze patient registration, test request entry, specimen flow, and test result entry in order to identify problems and alternative solutions.

Part of this study of specimen processing should include an analysis of the problem of *stats*. The literature indicates that *stat* turnaround time is a problem in both manual and automated systems. I believe that a careful study of the process would identify some changes that could be made that would help alleviate the problem.

Systems analysis of specimen flow is an important issue for both laboratories using a manual system and ones with automated support. It is possible that, in general, the manual information system of most laboratories could be improved sufficiently so that the laboratories could delay implementing a stand-alone laboratory MIS until an integrated MIS is available and operational for military hospitals.

The cost of conducting a systems analysis of the flow of specimens through the laboratory and the associated information through AFCLAS is relatively small, while the dollar savings of a more efficient personnel utilization are potentially significant. The potential nondollar benefits for more rapid turnaround time may also be great.

6. Consideration should be given to assigning computer operators additional responsibilities.

DISCUSSION: Because of the size and complexity of AFCLAS, the computer room must be manned 24 hours a day, 7 days

a week. According to the manning standards of the Management Engineering Team, this requires a minimum of five people. There were, however, eight people assigned during period Y. During that period, the computer operators were not fully utilized; this was, in part, because of a special situation at the Wright-Patterson AFB. A reduction in force for computer operators in the Air Force Logistics Command (AFLC) was in progress, and a number of AFLC operators were temporarily assigned to the laboratory at Wright-Patterson. Recent observations indicate that the situation has stablized and computer operators are more productive and are being integrated into the operation of the laboratory. The number assigned has been reduced to six. However, if this special situation had not existed, the computer operators would still not have been fully utilized. Thus, additional assignments of responsibilities should be considered. For example, one of the senior operators should be a programmer and operator, trained to do the majority of the routine computer file changes. A second senior operator might be given responsibility for training new laboratory technicians in the use of AFCLAS.

Another possibility is to assign computer operators the task of answering telephone inquiries about results. This would pose the question of whether laboratory technicians should be trained as computer operators to staff the computer room, or computer operators should be trained sufficiently in matters related to the laboratory tests. It is probably not desirable to train laboratory technicians to operate the computer. It may be more effective and efficient to give computer operators an overview of laboratory operations so that they can convey test results dependably over the telephone. In order to make these kinds of assignments acceptable to computer operators, their jobs may need to be redesignated as medical computer technicians and job descriptions written

to include both computer and non-computer tasks.

Assigning additional responsibilities to the computer operators would not increase cost and should eventually reduce cost when one of the receptionist or laboratory technician positions can be eliminated.

7. Consideration should be given to establishing the position of AFCLAS Systems Manager.

DISCUSSION: In addition to the number of laboratory officers authorized to operate the laboratory and required to insure proper test processing, a new full-time position of AFCLAS Systems Manager should be established to manage the day-to-day operation of AFCLAS, thus centralizing responsibility with one person. The duties of the AFCLAS Systems Manager would include the following:

- Managing AFCLAS operations and the computer room staff
- Serving as liaison with the medical staff and with other hospital staff
- Integrating AFCLAS capabilities and operation with the hospital operation
- Integrating AFCLAS capabilities with laboratory operations
- Supervising all training activities related to AFCLAS
- Serving as local contracting officer for vendor-supplied changes

The individual selected as AFCLAS Systems Manager should have as many as possible of the following capabilities and characteristics:

- Understanding of laboratory medicine
- Understanding of laboratory information and specimen flow through the hospital and the laboratory

- Training and experience in computer software
- Specific training by the vendor on the AFCLAS software (received after being identified for the position)
- Training and demonstrated experience as a good manager oriented toward human behavior.

Serious consideration should be given to whether the person should be a laboratory officer cross-trained in automated data processing (ADP) and management, or a person with primary training in ADP and then cross-trained in laboratory operations and management. In order for AFCLAS to be successful, the AFCLAS Systems Manager must have a close working relationship with the Chairman of Pathology and the flexibility to try different modes of operating the laboratory.

The addition of an AFCLAS Systems Manager with the rank of captain will increase costs by about $21,000 per year, which should be at least partially offset by decreases in cost due to more effective personnel utilization both inside and outside the laboratory. Additionally, there should be nondollar benefits of increased acceptance and satisfaction.

8. <u>The format for patient reports, test request cards, and test result cards should be pretested prior to AFCLAS installation</u>.

DISCUSSION: Patient reports, test request cards, and test result cards should be designed to be acceptable to the user. There was some physician dissatisfaction with patient reports in terms of format, amount of information on one page, and bulkiness of the patient record. While all physicians are not likely to agree on any one format, pretesting the proposed form with a group of physicians and making necessary revisions would produce a format usable and acceptable to the majority

of them and also aid in the acceptance of AFCLAS. Similarly, pretesting the test request cards and result cards would help create forms acceptable to both clinic and laboratory staff.

The cost of pretesting all formats and subsequent design is minimal and might greatly improve acceptance of AFCLAS. Further, if revised request forms are easier to complete, it is possible that significant personnel time would be saved.

9. Better vendor support immediately after system acceptance should be provided.

DISCUSSION: Shortly after AFCLAS was accepted by the Air Force, and before AFCLAS was fully operational from a functional point of view, the vendor withdrew software personnel from the site. It probably is desirable to require the vendor to provide a systems analyst onsite for several months after hardware acceptance. If the AFCLAS system acceptance criteria are modified to include 1 to 3 months of functional operation (of all software) before acceptance, then a vendor-supplied systems analyst after acceptance may not be required.

An onsite systems analyst would increase cost at a rate specified in the contract for the months the support is provided.

10. Consideration should be given to providing a capability for timely modification of AFCLAS software.

DISCUSSION: When a system such as AFCLAS is still in the developmental phase, it would seem desirable to provide for timely modification of software such that each site has the flexibility to tailor the system to its needs.

The identified requirement for printing outpatient reports in ascending terminal digit order (last 4 digits of the Social Security number) and the requirement for merging

patient records provide examples of the lack of timely modification of software. These two requirements were documented on 30 January 1976 in a memorandum from the AFCLAS User Group to the Directorate of Medical Plans, Office of the Surgeon General, but will not be implemented until spring of 1977. Other requirements for software modification documented in the same memo have not even been scheduled for implementation.

Two methods are available for implementing software changes. First, the Air Force could develop a closer working relationship with the vendor by purchasing software support on a continuing basis. The vendor should then become involved with the operations at each test site to develop a feel for their problems. The cost of providing this software support by the vendor is identified in the contract as a cost per man-month.

The second method for providing such software support would be for military or civilian personnel to provide the support on a full-time basis. This method of software support has several problems, such as determining the liability of the vendor for vendor-supplied software after government personnel have modified it. The cost of this option cannot be estimated accurately at this time.

Arguments can be presented for and against both options of software support, but given the Federal institution environment of AFCLAS, it probably is desirable to choose the option of vendor-supported software.

After a system has reached the stage of development where it is to be installed in several facilities as an operational capability, it is usually desirable to standardize software and only make changes through a central organization.

11. Consideration should be given to dropping Cytology from AFCLAS.

DISCUSSION: Although the basic time required to process Cytology specimens is essentially the same in both periods X and Y, additional time is required in period Y to enter the requests and results into the AFCLAS system. Dropping Cytology should save about 100 hours per quarter of laboratory supervisor time, which is equivalent to approximately $3,500 per year.

Any change in the time to file Cytology reports in Outpatient Medical Records in minimal, and hence, not a factor in the above analysis. Further, if Cytology is dropped from the system, the information is then no longer computer-accessible.

12. Meetings of AFCLAS User Group should be continued.

DISCUSSION: The meetings of the AFCLAS User Group have been effective in identifying problems, proposing solutions to problems, suggesting system modifications, and exchanging management and technical information about the AFCLAS system. I recommend that these user meetings be continued.

The cost is minimal compared with the benefit.

13. Establishment of a Medical Computer Systems Office should be considered for each site that will receive several information systems while they are still developmental systems.

DISCUSSION: The Medical Computer Systems Office at MCWP significantly contributed to the installation and initial operation of AFCLAS and MAMS-R by serving as a focal point for solving problems and by educating hospital personnel prior to system installation. I believe a similar

office should be considered for each hospital that will receive several developmental systems rather than production prototypes.

The cost of a Medical Computer Systems Office would range from $50,000 to $100,000 per year and should be considered part of development costs.

14. Consideration should be given to realizing more effective utilization of hardware and computer operators by utilizing the AFCLAS system for additional functions.

DISCUSSION: Entry and storage of patient demographic data requires significant personnel time and file storage, and the same or similar data will be duplicated in most of the MIS. The files of AFCLAS contain much of the data required for an inpatient medical administrative system. Also, with little or no hardware modifications, AFCLAS probably could support such a system. Implementing a second MIS function on AFCLAS hardware should make the system more cost - effective. The AFCLAS vendor has a functioning medical administrative system that is part of the Veterans Administration clinical laboratory system.

Implementing the inpatient medical administrative system or any other MIS on the AFCLAS system would add to system development costs. The decision to implement an additional function on the AFCLAS system should be made after investigating the dollar and nondollar benefits and costs.

15. Initial MIS design should consider impact on overall hospital operation.

DISCUSSION: The major objective of AFCLAS was "...to assist in the operation of clinical laboratories and to improve management of these facilities." I recommend that in designing future medical information systems, a more comprehensive

perspective be taken in order to consider the total needs of the hospital and the impact of a stand-alone system on hospital operation as a whole. To achieve this goal, a higher percentage of developmental funds should be committed to the design phase of the project.

If costs are to be controlled, special emphasis should be placed on the development of realistic system requirements and on dropping items that are unnecessary. Also, requirements should be matched carefully with existing and developing technology.

It cannot be concluded that all of the recent software modifications for AFCLAS would have been unnecessary if the design procedure discussed above had been followed, but I believe that at least some of them would have.

Overall development cost may be increased but cost of modifications during the contracting phase and subsequent to initial implementation should be significantly reduced.

16. Information systems, such as AFCLAS, should be treated as research and development systems in the development phase.

DISCUSSION: AFCLAS was purchased and managed as if it were a turnkey system with standard components. In reality, AFCLAS was a developmental system because the vendor had to modify the software to meet Air Force requirements. Also, it was the first clinical laboratory system to include a comprehensive operational Microbiology software package.

Developmental systems usually require special management and additional personnel. Until AFCLAS is developed to the point where it becomes an operational system, it should receive the special attention typically accorded a research and development system. This would, of course, entail additional costs in the development phase.

17. Period Y data collection should be scheduled as long as feasible after an information system such as AFCLAS becomes operational, considering the risk of additional intervening factors.

DISCUSSION: As previously discussed, the phenomenon of resistance to innovation, called *cultural lag*, is well documented in the sociological literature. This experience suggests that the physicians' and nurses' acceptance of and enthusiasm for AFCLAS will increase for at least several years after the system becomes operational. The Battelle study of the Technicon Medical Information System at El Camino Hospital found that physician acceptance of the system continued to increase for over 2 years after the system was operational.

While costs may or may not significantly decrease from those that would be observed in a shorter time period, staff acceptance of and satisfaction with the system should improve significantly and other qualitative benefits may also accrue. On the other hand, the longer the time between data collection periods, the more opportunity will exist for the occurrence of intervening factors; thus a tradeoff exists over time between increased staff satisfaction and increased uncertainty in attribution of causes of the effects observed in the evaluation.

18. AFCLAS provides a potential research data base.

DISCUSSION: AFCLAS is a start toward collecting reliable medical data for research studies. Consistent workload information collected over a period of years is useful at both the local and headquarters levels for resource allocation studies. Laboratory test ordering patterns by physicians or by physician specialty may be useful for studying resource utilization at the headquarters level and for hospital management at the local level.

C. Hardware Items

1. Consider substituting video terminals for Model 300 KSR terminals on the wards and in the clinics, and installing additional video terminals on all wards and most clinics to evaluate their usefulness.

DISCUSSION: Based upon interviews at the USAF Medical Center, Wright-Patterson AFB, physicians would like more terminals with faster response times located on the wards or in the clinics, while nurses would prefer quieter terminals. Both these needs could be met by video terminals or by higher speed, preferably quieter printers. Further, it is not clear that physicians require a printed report in response to requests entered on terminals on the wards or clinics.

Video terminals are most flexible and should be considered for a one-to-one replacement for all terminals on the wards or clinics. However, it may be desirable to leave printers in the Emergency Room and the Intensive Care Unit; in this case, the higher-speed Model 1200 KSRs should be substituted for the low-speed Model 300 KSRs.

Based on the June invoice for the AFCLAS system at Malcolm Grow Medical Center, hardware rental will decrease by $1,456 per year for each Model 300 KSR replaced by a video terminal, and the rental will be increased by $151 per year for each Model 300 KSR replaced by a Model 1200 KSR.

Since physicians expressed interest in more terminals, it may be desirable to install video terminals on all wards and in most clinics as an experiment to evaluate their usefulness. In addition to information retrieval, video terminals could be used for directly requesting laboratory tests--after appropriate software modification. The usefulness of direct ordering of laboratory tests via video terminals has not been proven but it is a concept worthy of further testing. For

each video terminal added to the AFCLAS system, hardware rental costs will increase by $1,114 per year.

If video terminals are installed, then the AFCLAS software should be modified to monitor terminal usage and to assess frequency of use and the appropriateness of the category of personnel using the terminal. Further, if AFCLAS is modified to allow for direct ordering of tests via video terminals, then the AFCLAS software should be further modified to count the number of tests requested via the video terminals. This software would increase cost but information gained should be useful for research.

It is possible that the video terminals for AFCLAS could service more than one MIS in the future if the appropriate communications interface is used. Moreover, if future MIS are designed to use compatible data, the interface problem is greatly simplified. Sharing video terminals among several MIS would distribute the cost of terminals and provide for user convenience. However, until additional MIS are introduced, increasing the number of terminals would clearly increase the operating costs of AFCLAS.

2. Consider developing an automated front end for AFCLAS that would be compatible with other Tri-Service Medical Information System (TRIMIS) systems and provide for rapid and convenient entry of demographic data and test results.

DISCUSSION: The current procedure for entering test requests and patient demographic data is cumbersome and time consuming. Mark-sense test request cards, admit cards, and patient registration cards must be filled out and then entered into the AFCLAS system in the reception area. Several options for automating the front end of AFCLAS are available. (As used in this paper, the front end of AFCLAS includes equipment

and procedures for entering into AFCLAS patient demographic data and test requests). The appropriate choice is too complex an issue, involving compatibility with other TRIMIS systems, to be addressed in this paper, but it is a pressing issue that deserves thorough analysis and careful consideration.

Some of the additional hardware costs will be offset by savings in manpower. Other benefits will be of a non-dollar nature.

3. Consider modifying the label printer to eliminate wasted labels.

DISCUSSION: During period Y, 43 percent of labels were wasted because of the poor construction of the label printer. To reduce this waste, the vendor has proposed using a different label design, but this will increase printing time since the number of lines printed is doubled. This is a poor interim solution which does not rectify the problem. I have seen at least one acceptable label printer in operation at a private hospital. Use of such an improved printer would increase costs somewhat. It may be more cost-effective to waste some labels than to purchase an improved printer.

4. Consider obtaining online differential terminals (counting stations).

DISCUSSIONS: In period Y, technicians performed differentials by counting the cells with the aid of a mechanical counter, recorded the results on a mark-sense card, entered the card into the computer, and then verified the results on the video terminal (CRT). A keyboard with a small CRT could be connected online to AFCLAS, such that the keyboard is used in place of

immediate verification. In addition to reducing technician time for processing differentials, this terminal would have the added benefit of decreasing turnaround time for *stat* differentials by facilitating immediate verification of results.

The cost of these terminals may be completely offset by a reduction in the personnel time required to perform the count manually.

5. Consider purchasing decollating and bursting equipment for the computer room.

DISCUSSION: Equipment to decollate and burst the patient reports would mechanically separate the two copies of the report, then remove the edges, and finally separate the sheets into two stacks of reports ready for filing.

Equipment to decollate and burst AFCLAS patient reports would cost about $3,000 and save personnel time in the Outpatient Medical Records Department, valued at $3,000 to $4,000 per year. Computer room personnel have time to operate this equipment at no additional cost.

D. Software Items

Since many of the following items will be corrected by contract modification P0014, or have previously been documented in the reports of the User Group meetings, the suggestions to be considered for software improvements are listed without discussion:

- Provide capability for outpatient reports to be ordered by terminal digit Social Security number.
- Provide capability for inpatient reports to be ordered by ascending hospital ID number.
- Provide capability for technicians to build their own accession list.

- Merge data from two data files with the same name and different Social Security number.
- Develop software to search the files to identify people who are in the file under two Social Security numbers and the same name.
- Modify software so that a patient can have an active inpatient and outpatient file.
- Continue to improve the operating system so that the time for offline end-of-day processing is decreased.
- Modify the software so that when entering a command through the terminal in a ward or clinic, there is a response message indicating that the command was accepted.
- The tests results calculation package, as defined for off-line tests (e.g., creatine clearance, estrogen calculations) was not functional and hence not used during period Y. It may be more cost-effective to drop this software requirement and provide the technicians with a simple hand calculator having several memory locations or with a programmable calculator.
- Improve the error messages for identifying the problem that causes the system to reject a test request or a patient registration card.
- Investigate the tradeoffs of having AFCLAS provide on-line verification of name and Social Security number against data stored in the files.
- Modify software so that all labels (for both *stats* and routine tests) are printed on the line printer in the computer room, sorted by ward, for morning venipuncture rounds.
- Require the system to provide more information useful for evaluating the effectiveness of AFCLAS.

- Revise test request forms and modify software to read them.
- Develop software to retrieve information from archival data tapes. (This could lead to storage of test results online for a shorter period of time, thus reducing the amount of required disk storage with a subsequent reduction in hardware rental.)
- Develop software for collecting statistics on *stat* test turnaround time so that this important parameter can be easily monitored.

All of these modifications will require a one-time cost for software modifications. Some will lead to a cost savings, such as the first item, which will reduce personnel costs in the Outpatient Medical Records Department by $3,000 to $4,000 per year. Some items will not reduce cost but will lead to improved system operation and nondollar benefits. The cost of these software modifications may greatly exceed the dollar benefits, but because of user satisfaction considerations they may be necessary if the development of AFCLAS is to be continued.

If AFCLAS data could be merged with diagnostic information from the Clinical Record Summary Tapes, then a large number of studies could be undertaken to investigate laboratory test effectiveness, utilization, reliability, and false positive and false negative rates.

I believe these research studies could ultimately improve the effectiveness and economy of the clinical laboratory and the delivery of health care. However, estimating the extent of such improvements in advance would be virtually impossible.

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This report presents the detailed findings of an evaluation of the impacts of installing a medical information system, the Air Force Clinical Laboratory Automation System (AFCLAS), at the USAF Medical Center, Wright-Patterson AFB.

The evaluation plan was developed by identifying 58 potential impacts of introducing AFCLAS in place of the existing manual

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ABSTRACT (Cont.)

information system. Some of the areas investigated in the evaluation were clerical tasks inside and outside the clinical laboratory; completeness of the medical records; time for processing laboratory test requests; and acceptance by, or satisfaction of, various personnel and patient groups. Data were collected at two different times—before and after AFCLAS was installed.

The evaluation included a cost-benefit analysis, as well as an analysis of the nondollar benefits of AFCLAS. The cost-benefit analysis showed that the expected cost of operating a clinical laboratory using AFCLAS was $382,123 more per year than the cost of operating a clinical laboratory using the previous manual system. The one-time installation cost of AFCLAS was an additional $91,631. The nondollar benefits of AFCLAS are: probable improvement in patient care, provision of cumulative reports, improved legibility of reports, easy retrieval of test results, additional information on reports, and improved report format.