Established Courses in the Allied Health Sciences

I. Medical Technology

A. Role.

The baccalaureate program in Medical Technology has been developed to provide Medical Technologists qualified (1) for work in clinical laboratories in hospitals, clinics, physicians offices, and other health agencies, (2) for work in research laboratories, and (3) for further training in the specialties. This program is the major source of Medical Technologists in this state.

The graduate program offering a M.S. in Medical Technology is designed to prepare graduate Medical Technologists for academic careers, or for administrative and consultative activities in laboratory methodology and teaching, or for work in a scientific specialty. This is the only graduate program in Medical Technology in this region.

B. Objectives:

1. B.S. Degree Program

The baccalaureate degree program in Medical Technology is designed to prepare young men and women to perform the duties and meet the responsibilities demanded in the practice of Medical Technology as an integral part of the total health care of the state. It has been estimated by Dr. John Godwin, of Emergy University, that optimally there should be 1 medical technologist per 20 acute general hospital beds. Rappaport recommended that a ratio of 10,000 tests per year per medical technologist be used as the basis for calculating the need for training medical technologists.

In the Clinical Laboratories of the University of Minnesota in 1965-66 the following utilization of medical technologists existed.

Number of Medical Technologists	76	(35% development and teaching = 50 equivalent)
Number of Medical Laboratory Assistants	14	
Number of Hospital Beds	750	1 MT/15 beds[1]
Number of Laboratory Determinations	932,421	18650 tests/MT[2]

[1]Reflects effect of the Out-patient Clinic beyond number expected for the bed capacity

[2]Reflects effect of teaching institution

For Minnesota with 17,281 acute hospital beds, 240 chronic hospital beds (25% as active) and 22,380 nursing home beds (10% as active), 980 medical technologists are needed for optimal patient services. Although exact figures are unavailable it is estimated that this is about twice the number of medical technologists working in patient service laboratories at the present time.

Surgeon General William Stewart has estimated that the need will increase 3% per year indicating the following needs.

		Minnesota	4 State Area
1970	-	1100	1830
1975	-	1265	2100
1980	-	1455	2420
1985	-	1675	2620

Another ratio which might be of value is the proportion of medical technologists (980) to physicians (5,270) or 1:5. Since the average professional career of a medical technologist is about 5 years and that of a physician exceeds 35 years the ratio of graduating technologists to physicians should be 1.5:1 just to staff the service laboratories. Since research laboratories also use medical technologists the actual need is closer to 2:1. In 1959 a survey in Minnesota by the State Department of Health indicated 119 (33%) additional Medical Technologists and 57 (20%) additional Laboratory Assistants were needed to fill existing job openings in 145 hospital laboratories in Minnesota. (This report excluded University of Minnesota Hospitals, Mayo Clinic, St. Mary's Hospital at Rochester, and the Veteran's Administration Hospital).

APPROVED HOSPITAL SCHOOLS OF MEDICAL TECHNOLOGY

State	Number	Student Capacity
Minnesota, University of Minn.	1	60
Minnesota (Exclusive of Univ. of Minn.)	11	131
Montana	4	24

APPROVED HOSPITAL SCHOOLS OF MEDICAL TECHNOLOGY con't.

State	Number	Student Capacity
North Dakota	5	64
South Dakota	7	44
TOTAL	28	308[1]

(1) represents 100% capacity; exact numbers of students enrolled in the program are not available.

2. M.S. Degree Program

The graduate program is designed to provide the opportunity for additional study at depth in one of the scientific areas within Medical Technology in preparation for work in methodology and research in a specialty, for supervisory activities, and for teaching in schools of Medical Technology.

Virtually all of the graduate education in this region for medical technologists planning to go into academic careers is in the College of Medical Sciences. The sizes and proposed expansion of the graduate program is limited by the available staff and facilities and is less than the indicated need for academic personnel.

3. Continuing Education

This division cooperates with other University Departments, professional associations, and other agencies in providing opportunities for continuing education by special courses, workshops, seminars, refresher training, and institutes in the interests of community service.

4. Auxiliary Programs

The one-year program for Medical Laboratory Assistants, originally initiated as an experimental program to design and test an educational program to train young women for work as technical assistants with activities limited to specific laboratory tests of routine nature, is now discontinued. Since this program has been well accepted and established at other training institutions, this Division will no longer take an active role in training but rather continue to act in an advisory capacity to existing programs and to new programs as they develop.

C. Program

1. Trends

It is apparent that the present methods of teaching and the "apprenticeship" training programs will not meet the changing needs in Medical Technology. Such changes are resulting from the increasing complexity and utilization of laboratory diagnostic procedures brought about by the phenomenal advances in scientific knowledge, automation, and instrumentation.

To meet these changing needs, the present curriculum in Medical Technology is currently being revised to allow more effective use of faculty and facilities and to provide not only effective basic knowledge in science but also in general education. The revisions are being planned:

a. to include more general education courses and to delete some overlapping science requirements.

b. to allow for more flexibility and less rigidity in the course requirements.

c. to include well-structured course offerings together with integrated laboratory exercises to strengthen and emphasize fundamental concepts in clinical laboratory science.

d. to de-emphasize student laboratory service requirements and practice.

e. to provide the student with a basic foundation of knowledge such that he can adapt to meet new situations and needs and that he can continue in advanced study.

It is important that increasing opportunity for graduate study is of prime importance. The present shortages of specialists and teachers in the field of Medical Technology is critical. At the present time there are only 10 universities offering graduate programs in Medical Technology. The graduate program here will have to be strengthened and increased to help provide personnel with additional education to meet the service and research needs in specialties and for teaching in schools of Medical Technology.

With the advent of automation and instrumentation into the clinical laboratory, there will be changing patterns of staffing, service and utilization of personnel bringing the need for changing education programs. It is the consensus that the effect of automation will not be to replace the technologist, but rather will be to require well educated and knowledgable personnel and will allow for expansion of services again requiring professional personnel. As stated by R. W. Coon, M.D., "It is easy to see that more, not less education and experience is needed to run one of these magnificent machines." Therefore, it can be anticipated that vigorous research programs in educational methods and procedures in laboratory methodology and service, and in personnel utilization will be and should be developed.

There are certain other areas within the field of Clinical Laboratory that are evolving and developing (and, indeed, some that are not even conceived at this point), that will require trained assistants and technicians. At the present time, the University does not have facilities to offer educational programs in these areas, for example, Cytotechnology, Histologic Techniques, Radioisotope work, etc. In fact, such programs can be well handled by other agencies. However, this division does have a responsibility to the state to assess trends and needs, to assist in developing additional programs or to engage in experimental programs to establish educational patterns.

As new techniques, automation, instrumentation, and methodologies are developed, the Division will have to be able to offer more opportunities for continuing education. Certainly more than can be done now with existing faculty and facilities will be expected and demanded by the community.

With increasing scientific knowledge and methodology in each of the units (Hematology, Chemistry, Microbiology, etc.) comprising the whole of Medical Technology, it is apparent that the need for specialty programs will develop. Such specialty training will probably be best handled as a year of training at the post-baccalaureate level.

2. <u>Needs</u>

In order to accomplish the objectives of our program and to fulfill our obligations to the people of this state, space, faculty and facilities are all major requirements. The present space and facilities are extremely limited and a are inadequate to meet even our present demands much less to meet increasing enrollments, or changing service, research, and educational needs.

Because of the clinical aspects of the program, it is essential that certain teaching laboratories be in close approximation to the clinical laboratories.

The new curriculum will require more general purpose teaching laboratories and class rooms because the students will no longer be in the hospital service laboratories to the extent of the current program. Such facilities probably could be planned as multiple-purpose laboratories and these could be shared with other clinical departments as appropriate.

If, in the future, enrollments in the baccalaureate program exceed facilities here, affiliations for clinical laboratory experience in local hospitals, and other health agencies can perhaps be utilized to our mutual satisfaction.

The following tables represent needs as best can be estimated at this time. It should be noted that this report concerns Medical Technology alone and does not represent the needs for the Department of Laboratory Medicine.

YEAR	1966 CURRENTLY HAVE	1966 CURRENTLY NEED	1970	1975	1980	1985
SPACE[1]						
Total Sq. ft.	1590	5305	8105	11405	12425	13215
Laboratories						
Teaching	800	1380	2160	3000	3240	3480
Research	0	750	1100	1550	1700	1800
Classroom	400	800	1260	1750	1890	2030
Other						
Offices (faculty)	360	1500	2200	3100	3400	3600
Offices (clerical)	30	210	350	560	630	630
Locker Space	0	665	1035	1445	1565	1675
FACULTY						
Academic[2]	13	15	22	31	34	36
Non-academic	3	3	5	8	9	9
STUDENTS						
(a) Undergraduates[3] 1 and 2 year	155		200	200	200	200
(b) 3 and 4 year[4]	105		150	200	200	200
(c) Specialties 5th year	0		10	20	30	40
(d) Graduate Students	11		20	30	40	50
(e) MLA[5]	60		0	0	0	0

(1) Space estimated according to figures from the reference: Laboratory Planning, H.F. Lewis, Reinhold Publishing Corp., New York, 1962.

(2) Faculty-student ratio of 1-8 (based on number of students in groups b, c and d.

(3) With the expected increase in junior college facilities, it is anticipated that the number of students enrolling at the U of M in the first and second years of college will level off.

(4) It is probable that the enrollment of the B.S. degree program should be curtailed at this level to allow for the utilization of faculty and facilities for the growth and development of specialty and graduate program.

(5) The MLA program will be phased out because other community facilities and agencies are being developed to offer vocational training programs for the medical laboratory assistant. (There are at present 113 CLA schools training 641 students in 34 states.")

JUSTIFICATION OF SPACE

I. Classroom space

a) Based on 7 square feet per student.

b) Plan includes not just one large room, but one to accommodate 100 students at a time and one or two smaller rooms for use for seminars and conferences for smaller groups.

c) Based on present usage and the projected plans for curriculum changes, it is anticipated that the "classroom" space would be utilized at least 75% of the time by the department.

	1970	1975	1980	1985
TOTAL SQUARE FEET	1260	1750	1890	2030
Number of students (all categories)	180	250	270	290
Hours per week	30	30	30	30
Quarters per year	4	4	4	4
Location need				
In department	10%	10%	10%	10%
Close to Dept.	90%	90%	90%	90%

II. Laboratory Space: Teaching and Research

a) Teaching space based on: $\frac{48 \text{ sq.ft./student}}{4 \text{ sections}}$ = 12 sq.ft./student

b) Laboratory exercises are an integral part of the instruction in all units of Medical Technology. Therefore, laboratory facilities are essential to any expansion of enrollment and curriculum changes.

c) Research space is based on 50 sq. ft. per faculty member. This figure represents a minimum estimate with sharing of facilities among several people.

d) Note: These figures fo not include clinical laboratory space for students during clinical service. These estimates should be included in the report from the Hospital Clinical Laboratory Service of the Department of Laboratory Medicine.

	1970		1975		1980		1985	
	T	R	T	R	T	R	T	R
Total sq. ft.	2160	1100	3000	1550	3240	1700	3480	1800
Number of students	180		250		270		290	
Number of faculty members		22		31		34		37
Period of use:								
hours/week	30	40	30	40	30	40	30	40
qtrs./year	4	4	4	4	4	4	4	4
Share with other departments to extent of time of	25%	0	25%	0	25%	0	25%	0

OFFICES

a) Estimates based on 100 sq. ft./faculty member
70 sq. ft./non-academic member

b) It is anticipated that some of this office space together with research laboratory space could be combined for office-laboratories for some faculty members and their graduate students

c) Non-academic category represents both clerical and technical personnel

	1970	1975	1980	1985
Number of faculty members	22	31	34	36
Number of non-academic personnel	5	8	9	9
TOTAL SPACE ESTIMATES SQ. FT.	3550	3660	4030	4230

LOCKER SPACE

a) Based on 5 sq. ft. per student and other personnel

	1970	1975	1980	1985
Number of students and personnel	207	289	313	335
Space Sq. Ft.	1035	1445	1565	1675

ORGANIZATIONAL RELATIONSHIPS OF CLINICAL LABORATORIES

The following description may be employed in conjunction with the accompanying conceptual diagram to indicate the most important functional relationships of the principal divisions in the clinical laboratories.

It is strongly suggested that one of the most important architectural principles which must underlie the design of the new laboratory facility must be the potential for expansion. Clinical laboratories have grown more rapidly than any other areas in the medical center, and continuing growth may be anticipated. This concept is indicated in the diagram by the zigzag lines bordering a number of the individual areas.

The clinical laboratories should be centralized to as large a degree as may be considered practicable. Satellite laboratories will probably be required in three major "old clinical areas," the Variety Club Heart Hospital, the Masonic Hospital and the Mayo Building.

Within the central laboratory complex I suggest that a common core be constructed consisting of a central specimen receiving and processing area, a central data processing area, a central emergency laboratory and the blood bank area. It is the easiest to consider this core area as existing in the new facility which will be developed; however, the concept of this four division core would be applicable wherever the central laboratories were located. The rationale for this core is apparent on perusing the accompanying diagram; however, a few of the cardinal advantages will be mentioned in this brief narrative description. All of the clinical laboratories may be closed down at night with the exception of this central core area. The central emergency laboratory would provide emergency service for the chemistry laboratory and the hematology laboratory during the day and for the chemistry laboratory, hematology laboratory and microbiology laboratory at night. Routine chemistry determinations and hematology determinations would be performed in a complex of highly automated laboratories adjacent to this core. All of the specimens may be processed through the central specimen receiving area and all units will tie in with the central data processing area.

The rationale for the inclusion of a central storage area and a central utility area is considered apparent.

Ideally, the central administration offices would also be located in this area and would have access to the central data processing area. This relationship is also illustrated in the diagram.

The role of the faculty in the Department of Laboratory Medicine is somewhat unique within the medical center. Faculty members are continually consulted throughout the day in reference to problems regarding hospital laboratory service and clinical methods research programs. They also have educational responsibilities. Ideally, therefore, the teaching laboratories of the School of Medical Technology and School of Medicine in relationship to the Department of Laboratory Medicine should be located close to the clinical laboratories as indicated in the diagram. It must be remembered that the medical technology students will be using specimens obtained from patients and that accordingly, these specimens will be processed through the central specimen receiving area. If it is impossible to locate the teaching laboratories adjacent to the clinical laboratories, the specimen transportation system, which is indicated schematically in the diagram, must be designed to transport specimens to the teaching laboratories. In any event it is considered imperative to have the methods research laboratories in the immediate vicinity of the central clinical laboratories.

The left side of the diagram indicates several specific problems in reference to clinical laboratory service. Patients in the outpatient clinic will require rapid laboratory service. If the outpatient clinics were located in the immediate vicinity of the central specimen receiving area, these patients could pass through this area and have their blood specimens and urine specimens procured at the central specimen receiving area. If this is not feasible, a satellite specimen receiving area and clinical laboratory will be required for the outpatient clinic.

The advantages of efficiency and economy in eliminating the duplication of satellite laboratories is apparent.

The emergency room service in our new medical center will be expanded several fold. This is also true of the intensive care unit as indicated in the diagram. These patients will require rapid laboratory service. If they are located fairly close to the central specimen receiving area, an additional satellite laboratory to serve these facilities will not be required. If they are remote from the central laboratory complex, our clinicians will demand satellite laboratory service for both of these areas. One additional problem in reference to specific patients should be mentioned in this description of an ideal facility. This problem concerns the pediatric patients in our new medical center. These patients will require specialized laboratory service in reference to specimen collection and specimen volume. Such laboratory service is not currently available in our medical center; however, there are several excellent facilities providing this service in laboratories currently in operation in the United States. The new medical center must take into account progress in this area and plan for such a service. Ideally it would use the central specimen receiving area previously described and the automated clinical laboratory service illustrated in the diagram. This specialized service may be more easily maintained if the pediatric micro laboratory is located relatively close to the pediatric patients. This functional relationship is illustrated in the diagram.

One final comment regarding transportation of specimens should be stated. Pneumatic tube systems have thus far proved unsuccessful because of the problem of blood constituents being altered during the period of transport. Nevertheless, the diagram suggests that a mechanical specimen transportation system should be developed both within the laboratory and throughout the medical center. Specimens could be transported to the central receiving area through the general hospital transportation system. A specialized system would be required within the laboratory using baskets and small elevators. These problems have been discussed with the Systems Planning Committee. They are mentioned in this report as they represent an important part of the central laboratory which is being planned.

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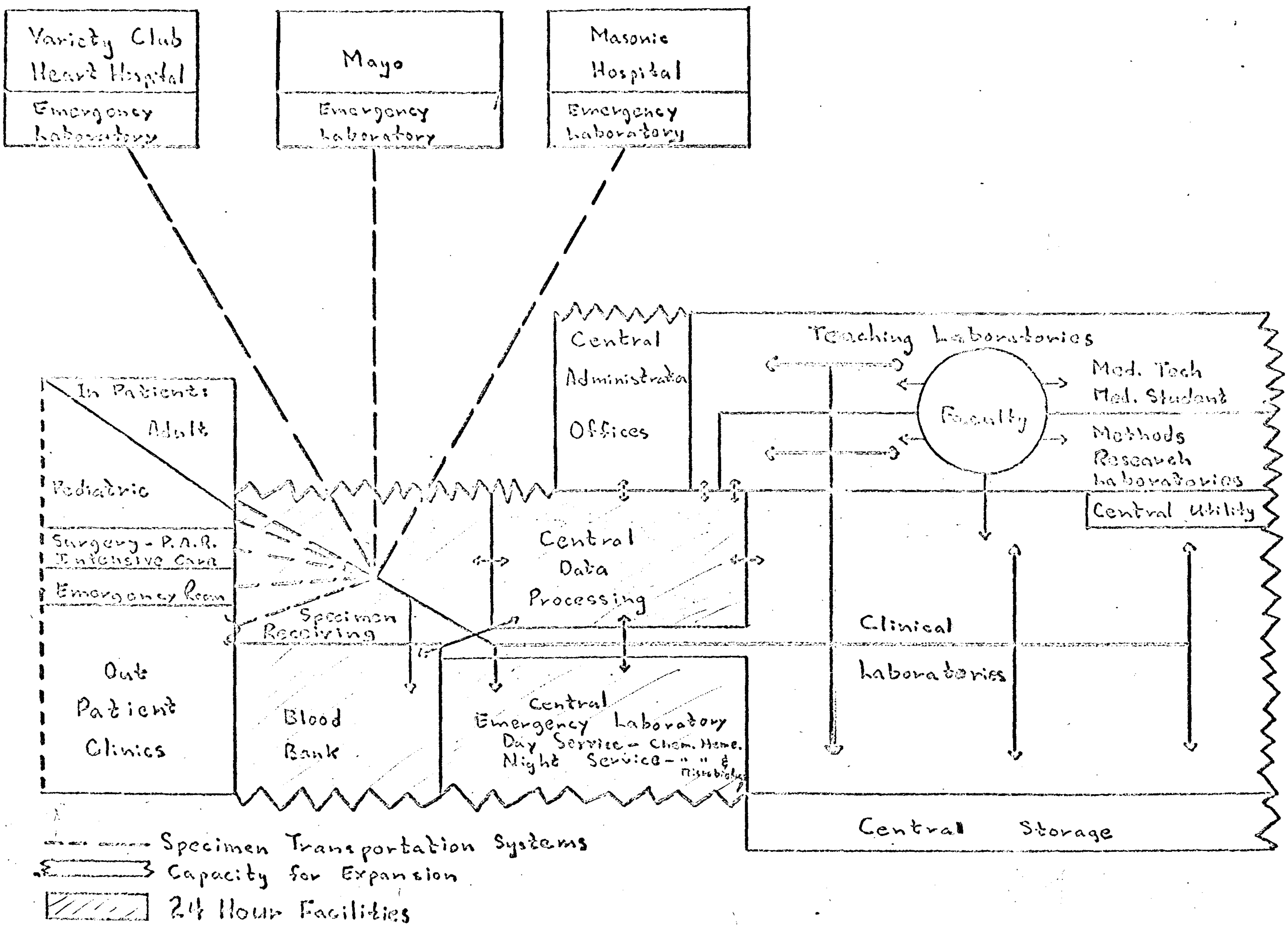

Variety Club Heart Hospital
Emergency Laboratory
Mayo
Emergency Laboratory
Masonic Hospital
Emergency Laboratory
In Patients:
Adult
Pediatric
Surgery - P.A.R. Intensive Care
Emergency Room
Out Patient Clinics
Specimen Receiving
Blood Bank
Central Administration Offices
Central Data Processing
Central Emergency Laboratory
Day Service - Chem. Hema.
Night Service - " " & Microbiology
Teaching Laboratories
Faculty
Med. Tech
Med. Student
Methods Research Laboratories
Central Utility
Clinical Laboratories
Central Storage
Specimen Transportation Systems
Capacity for Expansion
24 Hour Facilities

September, 1965

For the Hospital Task Force Clinical Medicine and Hospital Planning Subcommittee

Committee for the Study of Physical Facilities for the Health Sciences

FUTURE OF CLINICAL LABORATORIES AT THE UNIVERSITY OF MINNESOTA

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I. Introduction

The future development of the clinical laboratories will undoubtedly be determined by the tasks required of the University Medical Center itself and its teaching hospitals and clinics. They will also be to a large extent conditioned by the fact that an immense technical revolution is still taking place in this country and this revolution is effecting and will continue to effect the practice of medicine in many important areas. This revolution, as it relates to medicine has at least two notable aspects which are:

1. It is providing and will continue to provide important and varied advances in our knowledge of basic mechanisms of disease. This is being accomplished largely through the use of laboratory methods in the study of disease states. In the past few years it has resulted in a precise understanding of the fundamental mechanisms of a number of disease states including sickle cell anemia and galactosemia.

The effect that science has played on the management of disease is illustrated well by galactosemia. In this disease as well as in phenylketonuria our ability to make a diagnosis using very simple screening tests in infants makes it possible to completely ~~ablate~~ avoid the devastating effects of the disease by avoiding harmful dietary ingredients.

We, thus, can look forward to an increasing use of the laboratory in the ceaseless search for the mechanisms of disease. Using the knowledge thus gained, the laboratory will play an ever-expanding role in the detection and management of genetic disorders, notably those underlying physical and mental retardation, and other abnormal states now tragically unavailable to accurate early diagnosis and treatment.

2. Technical innovations will make laboratory examinations more efficient, rapid, accurate, and precise. These ~~will~~ innovations include: (a) automation, (b) improved quality control, (c) improved data processing through use of computers and other devices increasing the usefulness of the information gained through laboratory means, (d) multiple laboratory examinations as part of the initial examination of the patient, and (e) the availability of a complex and versatile laboratory facility which can provide "custom" service to suit the needs of an individual patient.

This technological revolution taking place in laboratory medicine will make it able more efficiently and effectively to play its role in the tasks that the University Medical Center itself has before it. My reading of the minutes of the meetings of the Hospital Task Force which have taken place to date and a reading of other pertinent documents such as the Coggeshall report suggests that these tasks may be described as follows:

1. Teaching Duties

In relation to laboratory medicine and the clinical laboratories these must be considered in the light of current manpower needs including: a. education of medical students; b. training of peri-medical laboratory personnel; c. retraining and refresher teaching activities, and

d. training of physicians as specialists in laboratory medicine.

2. Model Health Care Facility

The University Medical Center and its teaching hospitals and clinics must provide in the future model health care facilities for its geographical area of responsibility. One important, indeed essential, feature which will characterize the model teaching hospital and clinics of the future is efficient, versatile, reliable, and resourceful laboratory services.

II. Teaching Duties

With respect to educational efforts in laboratory medicine, hospital authorities have traditionally taken a major interest. It is safe to say that the development of a strong medical technology program could not have been a reality without the strategic and effective participation of the hospital administration.

Future developments and changes which may take place in the various areas of teaching responsibility may be the following:

a. Medical students. It is likely that more teaching of medical students in the use of the laboratory and in laboratory problems will take place as a part of their clinical years. This teaching will require, as at present in their medicine and pediatric clerkships, the use of laboratory facilities by the students. Increased teaching of the use of laboratory methods in the diagnosis and management of patients is foreseen. This will include problems of choice of laboratory methods, sources of error and other problems related to the interpretation of laboratory data. This type of teaching will require more time on the part of the physician staff of the laboratories and a close liaison between clinical service and the laboratory. It will probably mean some increase of the M.D. staff of the laboratory service.

b. Peri-medical laboratory personnel. In view of the probable shortage of physicians by the year 1972-73, a greater need for peri-medical laboratory workers is anticipated. In the state, a doubling or tripling of the number of laboratory technicians and medical technologists will be required within the next ten years. The category of peri-medical laboratory workers includes:

(1) Medical technologists. These will be trained much as at present except specialty training will likely take place within the four year program. In other words, only a limited number of individuals will be trained as general medical technologists. The majority will be trained as medical technologists and clinical chemists, microbiologists, etc. It is likely that the classes will continue to increase in size and we can anticipate that by 1970 the junior and senior classes will contain about 100 ~~medical~~ students technologists in each ~~present~~ class. By 1975 it is likely the classes will be about 150 in size. Obviously, the present senior year will have to be drastically revised if classes this large are to be accommodated. One of the probable changes is less use of apprenticeship type of training. The fact that automation is being increasingly utilized also dictates this change. More of the senior year teaching will be of the project type, in which the student is required to set up and evaluate a specific method.

These changes will require some alterations in staff and space. (a) An increase in the instructional staff will be required. It is anticipated that the medical technology teaching staff will increase from its present size of about 12 to a size of 24 in 1970 and perhaps 30 in 1975. (b) More teaching and classroom facilities will be required in the clinical laboratory area. The present 800 sq. ft. of teaching laboratory space and 400 sq. ft. of classroom space should become 2,400 sq. ft. and 800 sq. ft., respectively, by 1970 and approximately 5,000 sq. ft. and 1,200 sq. ft. by 1975. (c) Increased use of affiliated hospitals will have to be made, especially Ancker, Hennepin County General, and Minneapolis Veteran's Administration Hospital. These hospitals will become sites for senior year training by 1970, we hope. This will require that members of our teaching staff in medical technology be assigned to these facilities to provide an even level of quality throughout the program.

(2) Medical laboratory assistants. It will be necessary to continue to train technical workers at a lower level than medical technologists. I anticipate that the training program for medical laboratory assistants will continue. With increases in the number of training localities in the state (including junior colleges such as Hibbing and Fergus Falls, etc.) the increase in the number of students at the University of Minnesota Medical Center will not need to be as great as in medical technology. I estimate that the present 60 students per year will increase to 100 per year by 1972, that it will plateau there and perhaps drop somewhat by 1975 as other educational facilities begin to take up the load of teaching these students.

(3) I anticipate that the graduate program for medical technologists will become stronger and larger. These individuals who will have bachelor's degrees in medical technology will be trained to become supervisors and teachers of medical technology. The space and staff requirements that I have described will be sufficient for this effort.

To meet the needs for the increased number of medical technologists and medical laboratory assistants, it will be necessary to have a retraining program for individuals who have left the practice of their profession for a number of years to raise families. It will be advisable to provide a certain number of training positions in the laboratories and within the senior year of the medical technology program for this need.

Furthermore, the University will be obligated to provide more postgraduate education in medical technology and related fields in the years to come. It is likely that laboratory workers throughout the state will return to the University at periodic intervals (once every two years, for example) for training in new techniques and methods. Some of the support of such activity may be provided by such things as the President's Cancer, Stroke, and Heart Disease Program.

(4) More physicians will be entering the field of laboratory medicine. There will be more requirements for training of physicians in this specialty. The laboratory service will need physician directors and assistant directors in each of the laboratory divisions. In order to provide these people and to provide directors of hospital laboratories throughout the state, many physicians will need to be trained. Trainees will participate in teaching and in the service activities in the department as part of their training.

III. Model Health Care Facility

As I have indicated, the model health care facility of the future will draw strength from technological changes that are taking place in medicine. These have to do with the laboratory and its emerging functions in relation to the patient. Some of the aspects of these emerging functions of the laboratory are as follows:

1. The use of automatic methods of analysis will increase greatly. New instruments that are now being tested and are likely to be used

in the future will measure 8-16 different blood and serum components simultaneously on one sample. A great increase of speed and efficiency of analysis can be anticipated.

Many time-consuming procedures in areas such as hematology, urinalysis, and microbiology will become automated in the future and will provide new speed, efficiency, range and reliability of measurement and analysis.

In our experience, automation has not made it possible to reduce the size of the laboratory staff. On the contrary, concurrently the laboratory staff has grown to some extent but undoubtedly not nearly as much as it would have if not automation had taken place. In other words, if the laboratory were to handle the present workloads without automation, the staff in chemistry, for example, would probably have to be twice its present size. What this means is simply this: automation has made it possible for the laboratories to handle tremendous new demands placed upon it. Furthermore, the efficiencies effected by automation have increased the demands further still. It is likely that the volume of laboratory work required will continue to increase at least at its present rate if not faster in the 5-10 years just ahead. It will be required of us to continue to make strategic use of innovations that automation provides to keep up with this increasing workload.

2. Increased use of examinations as screening procedures will take place in the future. Automatic analysis makes it feasible that in the initial workup of a patient, 8-16 chemical analyses will be included, thus providing a saving in time, a probable reduction in the period of time needed for complete workup of a patient. The detection of unsuspected diseases will be an additional likely consequence of increased use of laboratory

tests in this manner. Initial trials at Duke University and at the Kaiser-Permanente clinics in California encourage one to believe that this type of use of the laboratory will become more widespread in the future.

In this same vein, the use of a number of laboratory analyses such as urine galactose and PKU to detect especially hazardous illnesses in children and adults makes it appear likely that more laboratory screening tests will become part of the basic examination in the near future. Economies effected by the detection and prevention of mental retardation in children will support such use. Dr. Robert Guthrie, originator of the Guthrie test, for example, points out that the detection of ten cases of PKU provided a saving to the state in corrective care of one million dollars.

3. The use of computers will make better and speedier data handling possible. Present instrumental innovations will provide in the very near future means by which the galvanometer current in autoanalyzers will be fed into a small computer and transcribed into units which can be directly placed on the patient's record. All of the intermediate calculations and facts will be made automatically. This will provide much greater speed and also reduce the incidence of calculation error. Besides, it will provide much better use of the data which we are now compiling. Computers make it possible to derive more information from laboratory measurements which will enhance the usefulness of the data. For example, it will provide comparisons with control sera for precision and reliability of measurement; comparisons with normal in the cohort group; comparisons with the patient's previous trials if previous examinations have been made; and comparisons at other times of day. Through these means it is likely that laboratory data can be

used much more critically and with more discrimination in both diagnostic and management problems.

4. More versatility and range of function will be possible in the future. In other words, the laboratory with its highly trained personnel should be able to take on extraordinary diagnostic problems and provide tools that may be needed for just one clinical case. For example, if a patient is suspected of having a rare neuromuscular disease, the laboratory will be able to make the crucial enzymatic analysis on serum and muscle required to arrive at a precise diagnosis. The laboratory of the future will participate more in individual case teaching of medical students by providing a discriminatory laboratory analysis of the case and by participating in discussions of meaning of laboratory data in relationship to the individual case.

IV. Space, Personnel, and Other Requirements

It is obvious from the foregoing that the laboratory ~~in teaching~~ service at University medical ~~students~~ centers of the future will require great resources and high priorities in terms of space and personnel. The equipment needed will need to be of the highest quality and dependability. It will probably be more expensive than that of the past since 8-~~12~~ 16 channel autoanalyzers and similar devices will be required. I emphasize that for purposes of economy alone it must be of the foremost quality since breakdowns followed by long periods of inactivity cannot be tolerated.

Personnel who will occupy these laboratories will be highly educated and skilled in laboratory medicine and in medical technology. It is paramount that there be large cadres of highly trained individuals to operate effectively the complex instruments which will be used. The present critical national and regional shortages in personnel in this field are not likely to continue since increased college enrollments in the science fields will attract many intelligent, able, and well educated young people into these specialized fields. They will be attracted only if a challenging opportunity, good working conditions, and a sense of professional responsibility and achievement are provided.

It is readily seen that large increases in space will be required. As we have noted, approximatley 3,200 sq. ft. will be required by 1970 for teaching alone and by 1975 this space is likely to be 6,200 sq. ft. In addition to this space required for offices and laboratories of teaching personnel and for the directors of laboratories, and for M.D. trainees will probably represent an additional 5,000 sq. ft. by 1975.

A 1,000 bed teaching hospital, Barnes Hospital and its associate hospitals in St. Louis, is now assigning, in their new central hospital facility, 60,000 sq. ft. for clinical laboratory services. For a 700 bed hospital, the United States Public Health Service now recommends 25,000 sq. ft. exclusive of peripheral laboratories such as EEG, ECG, and Heart Catheterization and also exclusive of research and teaching space. We presently have approximately 13,000 sq. ft. and will, when the Southwest Court is completed, have 25,000 sq. ft. This includes department teaching and research space and also EEG and ECG laboratories.

It is not unrealistic to suggest that for a 750 bed facility 15 years hence, approximately 51,000 sq. ft. will be required for the laboratory sections exclusive of departmental research space. A breakdown on this is as follows:

Chemistry including isotopes	20,000 sq. ft.
Hematology including unit laboratories in Heart Hospital, Masonic, etc. and including Out-Patient unit laboratory	15,000 sq. ft.
Microbiology	7,500 sq. ft.
Immunology	2,500 sq. ft.
Blood Bank	2,500 sq. ft.
Genetics and related facilities	3,500 sq. ft.

Our estimates are that an additional 12,500 sq. ft. will be required for teaching facilities. I am not at this time including any estimates for the research facilities for department members.

These estimates may seem somewhat large at first glance but are fully consistent with the emerging interest in both the teaching tasks of the medical center ~~and its hospitals and clinics~~ and ~~their~~ its needs to provide model health care facilities. I might add that in keeping with the experiences of the past both here and at other establishments, the cost of increased laboratory facilities and their continuing support will be made up largely by the increased volume of work provided, ~~the efficiency,~~ and the resultant improvements in health care and efficiency of medical management. It is likely that reductions in the length of stay of the patient will take place and in the amount of time required for workup and management in out-patient clinics. To the state, the saving will come in terms of improvements in the general level of health, in providing for well trained workers throughout the state, and in providing a center for hospitals and clinics throughout the state to look to for help and guidance.

PLANNING OFFICE COPY

UNIVERSITY OF *Minnesota*

OFFICE OF THE PRESIDENT · MINNEAPOLIS, MINNESOTA 55455

January 23, 1968

TO: Clinical Laboratory Committee

Dr. Ellis Benson, Chairman
Mr. Robert Turner, T.A.C.
Mr. William Berget, Setter, Leach and Lindstrom, Inc.
Dr. Paul Strandjord
Dr. Graham Beaumont
Dr. Edward Defoe
Dr. John Delaney
Dr. Michael Paparella
Mr. Eugene Johnson
Dr. Robert Vickers
Mr. Peter Sammond

FROM: Elmer W. Learn, Assistant to the President and University Planning Coordinator

SUBJECT: Planning Committee Assignment

As you know, we are moving rapidly toward definition of the health sciences development program in the form of preliminary schematics to be prepared by the Health Science architectural firms. It is essential that previous decisions relating to area relationships, special equipment and kind of space need be refined. These refinements must be documented with sufficient precision that the architects can proceed with the development of schematics.

In order to accomplish the above, we are asking you to serve as a special planning committee, chaired by Dr. Ellis Benson. Detailed questions will be brought to your attention by the architectural representative on the committee and the planning office staff. The realities of timing require a definitive report no later than March 1, 1968.

In your deliberations you may wish to consult with the subcommittee which developed the preliminary materials in this area. Dr. French chaired the clinical medicine committee. Mr. Sammond is chairman of the hospital committee.

In any case, it would be desirable if your report were reviewed by this subcommittee before being submitted to our office for review by the design and coordinating committee.

cc: Dr. Lyle French
Dr. Robert Mulhausen

CLINICAL LABORATORIES SUBCOMMITTEE

Minutes of the meeting February 7, 1968 (#1)

Present: Ellis Benson, Chairman; William Berget (Setter, Leach and Lindstrom), Peter Sammond, Paul Strandjord

Dr. Benson indicated that the Clinical Laboratories space requests predicted in the February, 1967, Planning Report Part III would have to be reconsidered in light of new programs, i.e., an extensive emergency room program.

Mr. Sammond felt the committee should focus its attention on realistically assessing space requirements rather than programming the space allocated in the Part III of the Planning Report. The task before the committee is defining required facilities and the question of feasibility is for the architects to consider.

Mr. Sammond noted that service facilities are scheduled to reach maximum capacity in terms of the number of inpatients served with the first phase of expansion. Laboratory expansion during Phase II will reflect an increase in the amount of lab work per patient. Dr. Benson projected that the quantity of laboratory work for the outpatient department would continually increase.

Mr. Berget distributed program planning forms and suggested one be completed for each laboratory specialty area and one for each shared central facility.

Drs. Benson and Strandjord agreed that it would be preferable to centralize all major sections of the laboratories since all draw on Specimen Receiving and Central Data Processing. It is particularly important to centralize laboratory facilities providing 24 hour service. Dr. Strandjord distributed a diagram indicating the interaction between laboratory areas as well as areas served.

CLINICAL LABORATORIES COMMITTEE

Minutes of Meeting February 9, 1968 (#1)

Present: Ellis Benson, Chairman; William Berget (Setter, Leach and Lindstrom), Eugene Johnson, Peter Sammond, Paul Strandjord, Robert Vickers

Dr. Benson discussed recent and anticipated growth in laboratory procedures and advances in laboratory equipment. The increase in the lab work load is due partly to the greater amount of lab work per patient and partly to the addition of new services. Automated procedures are being employed in the labs now for data processing and specimen receiving. Television is used in communications between the main labs and the clinic lab.

In the future, innovations in communications may limit the disadvantages of decentralized laboratory facilities. Dr. Benson expressed reservations about the transportation of specimens through pneumatic tubes. Mr. Berget suggested a mechanical conveyor system might be a more effective means of transporting specimens. The Department intends to utilize affiliated hospitals to handle future increases in lab tech students. The great demand for lab techs requires that the Hospitals not limit enrollment.

Dr. Benson listed the laboratory divisions that will have to be considered by the Committee: Chemistry, Hematology, Microbiology, Genetics, Immunology (including Blood Bank), EEG, EKG, EMG, Heart Cath, Pulmonary Function, Surgical Pathology.

Mr. Sammond outlined several planning considerations. With Phase I of the expansion program, beds will increase from 850 to 1,008. With the completion of Phase I, the complex will reach ultimate size with respect to patient care space. Future expansion will replace the beds in Mayo but patient areas will remain in Children's Rehab., Masonic and the Heart Hospital. Future increases in students will be handled by affiliations with other hospitals in the Twin Cities area.

The precise distribution of new beds has not been determined yet. Probably Psychiatric and Ob-Gyn beds will not increase and Surgery, Pediatrics, Surgery, Anesthesiology, and Intensive Care beds will. Emergency Room facilities will greatly expand and the Outpatient Department will increase to 150,000 visits/year in 1973 with an eventual capacity for 225,000.

Aside from the increase in beds, other considerations affecting the labs are that Obstetrics, without additional beds, will increase from 600 to 2,000 deliveries/year. Family Practice will probably require its own lab for teaching rather than service purposes. A substantial change in the method of handling diagnostic cases is planned. Diagnostic patients will stay at a motel-type facility while being treated in the clinics.

Dr. Benson mentioned that a multi-phasic diagnostic screening program is being considered for the OPD. The principle of the lab is to provide a thorough work up without relying on the physician. The screening lab will be ordered by the clinic physician and will probably be used most by Surgery, OB-Gyn and Psychiatry. Dr. Vickers added that alternation in laboratory policy of the State Board of Health is likely to increase the lab work.

Dr. Johnson urged the Committee to plan for flexibility in communication and transportation systems.

CLINICAL LABORATORIES COMMITTEE

Minutes of the meeting February 16, 1968 (#2)

Present: Ellis Benson, Chairman; Graham Beaumont, Bill Berget, Eugene Johnson, Robert Vickers, Michael Paparella, Peter Sammond, Paul Strandjord

Dr. Benson explained that planning for clinical laboratories encompasses planning for teaching as well as for service needs. Dr. Paparella asked if research facilities were also to be included. Dr. Benson felt the Committee's responsibilities included the research aspects of service and research facilities for division heads. Dr. Paparella proposed that research funds would be available for clinical laboratories if research and service were combined. Dr. Benson noted that NIH monies may be available for equipment in relation to development of computer applications.

Since the expansion of the clinical laboratories relates to directions of patient growth, Mr. Sammond outlined the planning proposals of the emergency room, the outpatient department, and the operating suite committees. The outpatient department space allocation is 103,000 sq. ft., an increase of four times the size of present facilities. New facilities will have a total capacity for 225,000 patient visits per year. The expected patient load by 1973 is 150,000. Emergency room facilities are expected to increase 2 to 2½ times their present capacity. The operating suite committee is requesting 27 or 28 operating rooms. The total number of new patient beds is expected to be 160.

Dr. Strandjord discussed areas of growth in laboratory work. He predicted tests will be ordered in screening batteries by the 1970's. Although there would be great advantage in centralized laboratory facilities, the use of computers and rapid transport systems should alleviate the disadvantages of decentralization and maintain high standards for response time--particularly for emergency room, intensive care unit, family practice, and outpatient department.

Dr. Johnson elaborated on the concept that automation trends would counteract decentralization problems and save space. An electronics repair shop will become mandatory as the Hospitals increasingly rely upon electronics equipment.

CLINICAL LABORATORIES COMMITTEE

Minutes of meeting February 27, 1968 (#3)

Present: Ellis Benson, Chairman; Graham Beaumont, Bill Berget, Jack Delaney, Eugene Johnson, Peter Sammond, Robert Vickers, Daniel Waite

Dr. Benson distinguished between core and peripheral laboratories. With the peripheral labs, the patient goes to the lab to have tests done. Consequently, it is expedient to have the lab located in the areas it services, i.e., heart catheterization in the VCHH. With core labs, however, centralized facilities provide the best utilization of space and staff.

An active Intensive Care Unit might well require a satellite chemistry-hematology lab to provide the fastest possible service and to facilitate repeats, as would an active Emergency Room. However, the committee emphasized that with adequate transportation and communication systems there would be no need for decentralized satellites. Reliable emergency service can be achieved through functional organization of the centralized laboratory. Centralized sub-units, responsive exclusively to the needs of the ICU or ER, would combine the advantages of both centralized and decentralized labs. Laboratories should include routine and special service facilities, and research and methods development facilities for each division. Special teaching labs are required for med techs although, with increasing automation, this provides more of a service to the state than to the Hospitals.

Dr. Benson summarized the formulation of space projections. Each division provided an estimate of its space needs. Projections for the peripheral labs are generous and the core estimates have been edited. Possibilities for further editing will depend on space allocations for research.

CLINICAL LABORATORIES COMMITTEE

Minutes of meeting March 7, 1968 (#4)

Present: Ellis Benson, Chairman; William Berget, John Delaney, Eugene Johnson, Peter Sammond, Paul Strandjord

State Role

The Committee discussed University Hospitals laboratories' responsibility to the state. Dr. Benson felt a regional laboratory should be a separate facility: the primary obligation of the laboratories now is to the Hospitals and an additional service role would not be efficient. Mr. Sammond noted that the Administration strongly feels that University Hospitals should serve as a regional resource. This need not be in a service capacity, but as an information or consultation center.

At present University Hospitals laboratories provide resources not available from commercial labs: a greater variety of services, emergency services and special consultation. Dr. Strandjord pointed out that commercial labs use the most economical methods whereas the most economic means are not always the most accurate. Mr. Sammond felt it was in this area of service not provided by commercial laboratories that the Hospitals should develop as a state-wide resource.

Centralization

The Committee again agreed that if the Outpatient Department and Emergency Room are located so that specimen can be effectively transported, it would be preferable to have the core laboratories centralized. Dr. Benson suggested the ICU is a likely candidate for a 24 hour satellite laboratory, but the Committee agreed that the duplication of staff and equipment could and should be avoided with the development of adequate transportation and communications systems.

Research Facilities

Mr. Sammond observed that programming of clinical laboratories space called for faculty research space rather than methods development space. He added that it is easier to administer service and research budgets if the areas are separate and predicted that cost accounting and strictures on patient care and research are likely to become more stringent. Dr. Benson noted that the staff feel the two areas should not be separated, that the duplication of expensive equipment is not practical. Dr. Johnson suggested that the time has come to confront the sharing of research and service facilities and make it an acceptable practice.

UNIVERSITY OF Minnesota

COLLEGE OF MEDICAL SCIENCES
DEPARTMENT OF LABORATORY MEDICINE • MINNEAPOLIS, MINNESOTA 55455

March 11, 1968

TO: Members of the Clinical Laboratory Space Planning Committee

FROM: E. S. Benson, M.D., Chairman

The enclosed addendum to the report from the Department of Laboratory Medicine on space requirements for clinical laboratories includes a brief description of the relationship of the proposed expanded laboratory to the community at large. It also includes estimates of needs for a screening laboratory, laboratory computer and data processing facilities and satellite laboratories in the emergency room and the intensive care unit. Please add it to the report which you have received. Thank you.

ESB:cj
Enc.

ADDENDUM TO THE DEPARTMENT OF LABORATORY MEDICINE PROPOSAL FOR THE 1973 CLINICAL LABORATORY PLANNING COMMITTEE

I. Additional background material related to the mission and function of the clinical laboratories at University Hospitals.

The proposals as they are drawn relate laboratory function exclusively to the needs of the University Medical Center, including the hospitals and clinics. The laboratories also have major roles to play in the community at large, including the metropolitan community and the State of Minnesota. These roles lie in the areas of service, teaching and research. In the area of service, these laboratories and their staff provide a resource to the entire community of special skills and special analytical know how. The laboratories act as a reference laboratory for many hospital laboratories in the area and for the State Boards of Health of Minnesota and Wisconsin. The laboratories are also a reference laboratory for the United States Public Health Service Communicable Disease Center Program in national laboratory evaluation. They also are a reference laboratory for the College of American Pathologists.

Besides these reference activities, they provide special analytical procedures in areas of a type that are not available in most other hospital and clinic laboratories in the State. Beyond this, the staff of the laboratory provides consultant and advisory resources to pathologists and medical technologists throughout the state.

In the realm of teaching, these laboratories are an important resource to the state in the areas of clinical pathology training and medical technology education. Many of the pathologists in clinical laboratories in this state have received some or all of their training in clinical pathology in the Department of Laboratory Medicine at the University of Minnesota. Through means of workshops and continuation courses, the Department provides programs of continuing education for both pathologists and medical technologists.

This Department and the laboratory services are an important resource for the training of medical technologists, both at the undergraduate and graduate level. With a class size of 50 to 60 students, this is the largest medical technology school in the area and one of the largest in the United States. Its reputation is very high among clinical laboratory specialists and the graduates of the school are in demand as supervisors and technologists.

The graduate program in medical technology is providing teachers and supervisors in medical technology for hospitals and hospital-based schools throughout this region.

The laboratory services are a potent resource for the teaching of the use of laboratory methods to physicians in general. The critical use of high quality and resourceful laboratory services is an important part of the teaching of physicians in the medical school and the postgraduate training of specialists at the University of Minnesota Medical Center and its affiliated institutions in the Twin City area.

In the area of research, the laboratory services provide a continuing high quality program in development and testing of new methods and analytical approaches to clinical problems. It furthermore provides demonstrations of new approaches to health care. In the latter area, a notable example is the program in electronic data processing now underway.

Another research approach which is planned in the new facility is the use of laboratory screening methods for detection of a variety of cryptic diseases as a part of a general medical examination. It is also planned that there will be special types of screening profiles for special purposes, such as patients with suspected liver disease, renal disease, metabolic defects, etc. This type of activity will have research and teaching value in the Center and in the community as a whole.

II. Plans for establishing a screening laboratory or unit and the needs of the computer program in the laboratory area have been taken into account in the proposals already submitted to you. These are planned as a part of the Chemistry Division as it has been proposed to you. The square foot requirements for chemistry include thus a screening laboratory and the requirements in the laboratory for space for the computer program.

III. Additional satellite laboratory requirements will be necessary if the emergency room and intensive care unit are expanded and are at sites remote from the central laboratory divisions. Accordingly, we propose an emergency unit laboratory capable of operating on a 24-hour basis in the emergency room. Approximately 200 square feet of laboratory space should be planned in the emergency room area for this purpose.

An additional laboratory space should also be planned for the intensive care unit. This also would be an emergency laboratory capable of operating on a 24-hour a day basis providing emergency analytical procedures in chemistry and hematology. Approximately 400 square feet will be needed for this purpose in the intensive care unit.

These estimates for satellite laboratories are in addition to the space requirements previously estimated.

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I. Clinical Laboratory Divisions Considered in This Report

A. "Core" Laboratories

Chemistry
Genetics
Hematology (including Coagulation)
Immunology (including Blood Bank)
Microbiology (including Virology)

B. "Peripheral" Laboratories

Cardiac Catheterization
Electrocardiography
Electroencephalography
Electromyography
Pulmonary Function
Surgical Pathology

II. Ideal Functional Relationships of the Clinical Laboratories

The laboratories have been divided into two groups. The discussion in this section pertains to those laboratories which should be located in a central complex if practicable. The rationale for this recommendation is presented in this section along with the desirable interrelationships of the laboratories which would be located in this area. The other units may be located as appropriate throughout the medical center. Surgical Pathology, for example, should be located near the operating rooms.

The following description may be employed in conjunction with the accompanying conceptual diagram to indicate the most important functional relationships of the principal divisions in the central clinical laboratories.

One of the most important architectural principles which must underlie the design of the new laboratory facility is the potential for expansion. Clinical laboratories have grown rapidly, and continuing growth may be anticipated. This concept is indicated in the diagram by the zigzag lines bordering a number of the individual areas.

Within the central laboratory complex we recommend that a common core be constructed consisting of a central specimen receiving and processing area, a central data processing area, a central emergency laboratory and the blood bank area. It is the easiest to consider this core area as existing in the new facility which will be developed; however, the concept of this four division core would be applicable wherever the central laboratories were located. The rationale for this core is apparent on perusing the accompanying diagram; however, a few of the cardinal advantages will be mentioned in this brief narrative description. All of the clinical laboratories may be closed down at night with the exception of this central core area. The central emergency and the hematology laboratory during the day and for the chemistry laboratory, hematology laboratory and microbiology laboratory at night. Routine chemistry determinations and hematology determinations would be performed in a complex of highly automated laboratories adjacent to this core. All of the specimens may be processed through the central specimen receiving area and all units will tie in with the central data processing area.

Ideally, the central administration offices would also be located in this area and would have access to the central data processing area. This relationship is also illustrated in the diagram.

The rationale for the inclusion of a central storage area and a central utility area is considered apparent.

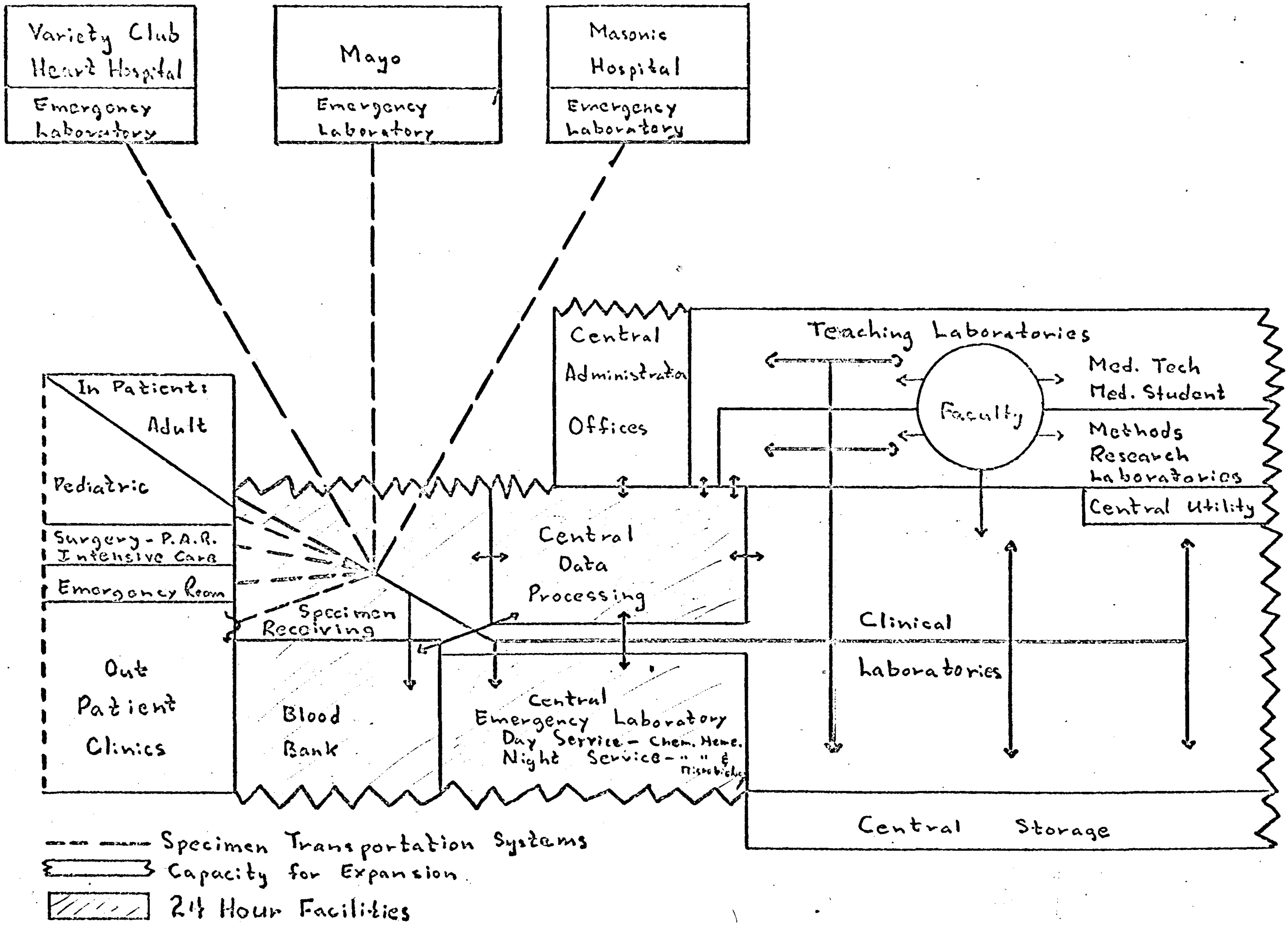
Although the clinical laboratories should be centralized to as large a degree as may be considered practicable, small satellite laboratories will probably be required in the other major clinical areas. Thus, if the central clinical laboratories were located in the new facility, small laboratories would probably be needed in the three major "old clinical areas," the Variety Club Heart Hospital, the Masonic Hospital and the Mayo Building.

The role of the faculty in the Department of Laboratory Medicine is somewhat unique within the medical center. Faculty members are continually consulted throughout the day in reference to problems regarding hospital laboratory service and clinical methods research programs. They also have educational responsibilities. Ideally, therefore, the specialized teaching laboratories for senior students in the School of Medical Technology should be located close to the clinical laboratories as indicated in the diagram. It must be remembered that the medical technology students will be using specimens obtained from the patients in these laboratories and that accordingly, these specimens will be processed through the central specimen receiving area. As illustrated, the methods research laboratories should also be located in the immediate vicinity of the central clinical laboratories.

The left side of the diagram indicates several specific problems in reference to clinical laboratory service. Patients in the outpatient clinic will require rapid laboratory service. If the outpatient clinics were located in the immediate vicinity of the central specimen receiving area, these patients could pass through this area and have their blood specimens and urine specimens procured at the central specimen receiving area. If this is not feasible, a satellite specimen receiving area will be required for the outpatient clinic. An additional clinical laboratory will also be required unless a rapid transportation system for specimens is available. The advantages of efficiency and economy in eliminating the duplication of satellite laboratories is apparent.

The emergency room service in our new medical center may be expanded. This is also true of the intensive care unit as indicated in the diagram. In any event, these patients will require rapid laboratory service. If they are located fairly close to the central specimen receiving area, additional satellite laboratories to serve these facilities will not be required. If they are remote from the central laboratory complex, our clinicians will demand satellite laboratory service for both of these areas. One additional problem in reference to specific patients should be mentioned in this description of an ideal facility. This problem concerns the pediatric patients in our new medical center. These patients will require specialized laboratory service in reference to specimen collection and specimen volume. Such laboratory service is not currently available in our medical center; however, there are several excellent facilities providing this service in laboratories currently in operation in the United States. The new medical center must take into account progress in this area and plan for such a service. Ideally it would use the central specimen receiving area previously described and the automated central clinical laboratory service illustrated in the diagram. This specialized service will be more easily maintained if the nursery is located relatively close to the central laboratories. This functional relationship is illustrated in the diagram.

One final comment regarding transportation of specimens should be stated. Pneumatic tube systems have thus far proved unsuccessful because of the problem of blood constituents being altered during the period of transport. Nevertheless, the diagram suggests that a mechanical specimen transportation system should be developed both within the laboratory and throughout the medical center. Specimens could be transported to the central receiving area through the general hospital transportation system. A specialized system would be required within the laboratory using baskets and small elevators. These problems have been discussed with the Systems Planning Committee. They are mentioned in this report as they represent an important part of the central laboratory which is being planned.


Variety Club Heart Hospital
Emergency Laboratory
Mayo
Emergency Laboratory
Masonic Hospital
Emergency Laboratory
In Patient:
Adult
Pediatric
Surgery - P.A.R.
Intensive Care
Emergency Room
Out Patient Clinics
Specimen Receiving
Blood Bank
Central Administration Offices
Central Data Processing
Central Emergency Laboratory
Day Service – Chem. Heme.
Night Service
Teaching Laboratories
Faculty
Med. Tech
Med. Student
Methods Research Laboratories
Central Utility
Clinical Laboratories
Central Storage
Specimen Transportation Systems
Capacity for Expansion
24 Hour Facilities

III. Possible Modification of the Central "Core" Clinical Laboratory Concept

As indicated in Part II, Ideal Functional Relationships of the Clinical Laboratories, there are many inherent advantages in including as many of the divisions in the department as possible within the central core clinical laboratory. As plans for the medical center develop, however, this centralization may not be practicable. Accordingly, a number of possible alternatives are included in this section of the report.

A. The central clinical laboratory complex should include the following facilities, even if complete centralization cannot be achieved:

   1. Central Specimen Processing Area
   2. Central Data Processing Area
   3. Central Emergency Laboratory
   4. Clinical Chemistry Laboratories
   5. Clinical Hematology Laboratories, including the Coagulation Laboratory

B. If necessary, the Blood Bank and Immunology Laboratories could be separated from the central core.

C. The Microbiology Division could be separated from the central core, if necessary.

D. The Genetics Laboratory, Cytogenetics and Chemical Genetics, could be separated from the central core.

E. Prompt laboratory service will be required for the Emergency Room, Intensive Care Unit, and Outpatient Service. As discussed in Part II, laboratory service for these units could be handled efficiently in the Central Laboratory Core provided that specimens could be rapidly transported from these areas to the Central Specimen Receiving Area. Ideally, the Emergency Room, Intensive Care Unit and Outpatient Service would be located geographically in proximity of the Central Specimen Processing Area. In any event, if it will be impossible to transport specimens from these areas to the central laboratories within several minutes, seven days a week, 24 hours a day, peripheral laboratories will have to be developed in the immediate geographical area of these facilities. The problems inherent in these peripheral laboratories include duplication of equipment, inadequate supervision by the academic faculty and staffing requirements at night.

IV. Discussion of the Role of the Clinical Laboratories in the Delivery of Health Care in the 1970's

The Department of Laboratory Medicine projection reflects the requirements of 1973. Since it may be assumed that growth will continue, the potential for expansion is critical. The facility as planned will not be adequate for 1978, and with this in mind it is possible that the current estimates for service required in 1973 should be increased somewhat. In any event, expansion prior to 1980 will probably be required, and this expansion should be anticipated by the architects planning the 1973 center.

A. Chemistry

The number of determinations performed by the chemistry laboratory staff has increased approximately 20% per year during the past seven years. This growth reflects both a greater variety of procedures and a larger number of analyses performed per procedure. The increase can be attributed primarily to a larger number of laboratory tests performed per patient since the number of patients has remained relatively constant over the period.

The chemistry laboratory staff and faculty have increased approximately one hundred per cent during the past five years. The number of analyses performed has also doubled during this period. Concurrently, the laboratory has automated many methods and instituted a number of procedures to increase efficiency. Additional new procedures and increased work volume can be anticipated in the future.

Eventually, the growth rate will probably plateau; however, during the next five years we would predict a similar increase in work volume. We would estimate that the rate of increase in personnel would be decreased by about 50%. Hence, we would assume a civil service staff in the chemistry division of approximately 75 people in 1973. By 1973 full time civil service personnel will undoubtedly staff the laboratory seven days a week, twenty-four hours per day. In addition, new clinical programs such as organ transplantation may be anticipated. Hence, 75 may be a conservative estimate.

B. Genetics

Space requirements for this laboratory were underestimated from its inception. The fast growth of the biochemical genetics has forced us to provide research space for amino acids, glycolysis testing and autohemolysis. It is predicted that we would need two Beckman amino acid analyzers by July 1969 and three of them for 1971. Automation of other tests such as PK and glucose for erythrocyte glycolysis is expected in a five-year period. There is also a need for isotope space (i.e., scintillation counter) and a chromatography and ELP room since new procedures commonly need these items. In five years'time we should also be routinely doing a "package" of biochemical tests in all newborns at this hospital.

We fully expect that the cytogenetics service will become automated in the next 5-10 years and karyotyping would become a routine test for all newborns. (1/200 newborns have a gross chromosome defect.)

Special services will become available. For example, testing the effect of LSD on chromosomes of LSD treated patients, and karyotype analysis of amniotic fluid, rectal polyps and uterine curettage is anticipated. Requests of this type have already been made, but lack of space and staff have forced us to decline them.

C. Hematology (including Coagulation)

1. All routine procedures will conceivably be automated with the exception of differentials. However, it is possible that even differentials will be automated by the end of 1970.

2. All results will be monitored by the computer. This will eliminate erroneous results by comparing previous test results.

3. Monitors for patient hemoglobins (similar to cardiac monitors) for G.I. bleeders will be available and functioning by 1970.

Services added within the past year:

Serum Vitamin B_{12} assay
Serum and red cell Folic Acid assay
Studies for paroxysmal nocturnal hemoglobinuria
Stain for fetal hemoglobin
Routine PAS staining of smears and sectioned bone marrow
Peroxidase, Sudan Black B, Toluidine Blue, Acid Phosphatase, and Aryl sulfatase stains of blood and bone marrow when necessary
500 cell differentials on renal transplant patients on immuno-suppressive therapy
Immunofluorescence (so far research) on globulins in plasma cells, and fluorescent proof of amyloidosis

It is expected by comparing the services added within the past year, that by 1970 the workload and space requirements will proportionately increase to keep pace with the growth of the tests conducted by the hematology laboratories.

4. Coagulation

The present service space is utilized primarily for the coagulation screening tests. The number of coagulation screening tests to be done will surely increase. In particular, a several fold increase in PTT's and thrombin times is to be expected. At the moment, two persons are working full time in this laboratory doing coagulation factor assays. We are sure that the clinical coagulation laboratory will soon require at least four full-time persons. In addition, space will be required for additional equipment. Such equipment will include a UV spectrophotometer, platelet aggregation test unit, space for FDP assays, additional freezer storage space, an additional balance, and perhaps a Coulter counter. Six full-time technologists will probably be required in 1973.

<u>Tests now done</u>:

Whole blood clot retraction
Prothrombin time
Partial thromboplastin time
Thrombin time
Euglobulin clot lysis
Platelet adhesiveness
Whole blood clot lysis
Two-stage prothrombin test

Tests to be added:

Fibrinogen and cryofibrinogen - various methods
Fibrinogen titer
Assays for plasma factors II, V, VII, VIII, IX, S, XI and XII
Plasminogen
Plasminogen activator
Bleeding time
Platelet factor 3 availability with various reagents
Platelet aggregation with various reagents
ADP degradation in plasma
Fibrinogen degradation products assay
Factor VIII inhibitor study
Factor XIII quantitative assay

The increasing recognition of hemostatis problems in a wide range of clinical situations will continue to increase the work of the coagulation laboratory.

D. Immunology (Including Blood Bank)

1. Transfusion (I.V.) team for administration of blood transfusions
2. Increased use of blood components - requiring specialized equipment for preparation, storage and dispensing.
3. Radioisotope facilities for tagging of red cells, white cells and platelets.
4. Cryo-biological facilities - "tissue bank"
   a. Freezing blood, blood components, bone marrow, lymphocytes, and organs (e.g., kidneys)
   b. Tissue typings
   c. Studies and treatment of patients with deficiencies of function of myeloid cells, lymphoid cells, platelets.
5. It is anticipated that in the near future, emergency service will need to be provided to type the histocompatibility factors in patients with imminent death (neurosurgery, traumas, etc.) which will serve as prospective donors for homotransplantation.

Director and Professor of Clinical Immunology

Blood Transfusion

Director - M.D.
Instructor
Principal Medical Tech.
Senior Medical Tech.
3 Secretaries
10 Medical Tech.
4 Laboratory Ass'ts.

Functions:

1) Blood groups
2) Compatibility
3) Autoanalizer

Immunohematology

Experienced person
3 technologists
3 Laboratory assistants
2 Radioisotope techs.

Functions:

1) Erythroblastosis fetalis
2) Autoimmune-hemolytic anemia
3) Transfusion reactions
4) White cell antibodies
5) Red cell antibodies
6) Platelet antibodies
7) Cell survival

Diagnostic Immunology

Director
Instructor
Principal Tech.
6 Technologists
2 Laboratory Ass'ts.

Functions:

1) Connective tissue diseases
2) Diagnostic serology
3) Immunological methods for determination of hormones
4) Allergy
5) Immunochemistry
   a) Complement
   b) Immunoglobulins

Transplantation

Director
Secretary
2 technologists
3 Laboratory Ass'ts.
2 Cryobiologists

Functions:

1) Tissue typing
2) Family program
3) Cadaver program
4) Records of patients and donors
5) Cryobiology lab.
   a) Blood storage
   b) Organ storage
   c) Bone marrow storag
   d) Lymphocyte storage

Transfusion Team and Donor Room

10 nurses or
6 nurses and
4 phlebotomists

E. Microbiology (Including Virology)

As an estimate of the growth in work volume which can be anticipated over the next five years, the following figures for the past five years are quoted.

Year	Number of Procedures
1962-63	42,204
1963-64	47,997
1964-65	53,483
1965-66	63,076
1966-67	63,297

49% increase during five year period

The greatly increased clinical communication in this division and the increased activity in organ transport, drug therapy for cancer patients suggests realistically that the workload could increase as much as 100% in the next five years. Each diagnostic problem related to infectious disease increases the number of tests per patient so that it is doubtful that automation will decrease service facility requirements.

Development of a diagnostic virology laboratory is long overdue. Advances in diagnostic virology have made this service mandatory in a University Hospital. As stated previously, there is active recruitment for a clinical virologist and the provision of this diagnostic facility would greatly enhance this recruitment.

F. Computer

This entire division is an innovation irrespective of new or expanded hospital facilities. Anticipated future needs include conduits connecting our center with every nursing station despite the fact that at present CRT displays on each station are considered to be uneconomical. With the present trend in wages and electronic equipment, the situation may well be reversed within a few years.

Other long term developments in data handling include 1) possibility of data link to National Medical Library, 2) teleconference room, and 3) taped medical education. We are assuming that these ideas are taken care of in the general planning of the center. We would like to reserve space in this connection within the framework of central planning, but cannot ask space here separately. However, we consider it necessary that such space be planned for the whole hospital.

V. Summary of Space Requirements of the Clinical Laboratories of 1973

I. Central Facilities:

A. Central Core Facilities

1.	Central Office Complex	2,640
2.	Central Utility	1,720
3.	Central Storage Area (Instruments & Reagents)	1,900
4.	Central Specimen Receiving & Processing Area	1,200
5.	Central Data Processing Area	1,350
6.	Central Emergency Laboratory	1,800
	SUBTOTAL	10,610

B. Central Division Facilities

1.	Chemistry Division	15,390
2.	Hematology Division (including Coagulation)	15,130
3.	Genetics	3,810
4.	Microbiology (including Virology	6,010
5.	Immunology (including Blood Bank)	11,560*
	SUBTOTAL	51,900
	TOTAL	62,510

C. Peripheral Laboratories:

1.	ECG	2,838
2.	EEG	3,160
3.	Surgical Path.	3,130
4.	Pulmonary Function	2,510
5.	Heart Catheterization	
6.	EMG	
	TOTAL	

Chemistry Work Sheet

1. Offices

Director	150 sq. ft.
Bridges	120
Brown	120
Rosenberg	120
X	120
Med Tech 8 x 120	960
	1,590 sq. ft.

2. Methods Research Space

Rosenberg	900 sq. ft.
Benson	900
Strandjord	900
Bridges	900
Brown	600
Added Person	300
Freier	400
Hallaway, Clayson	400
Merritt, J. Hansen	200
X, Y, Z	300
Research & Development Space	600
	6,400 sq. ft.

3.	Service Lab Space	5,400 sq. ft.
4.	Division Teaching	1,200 sq. ft.
5.	Graduate Teaching	800 sq. ft.
	TOTAL	15,390 sq. ft.

STUDIES OF THE UTILIZATION OF
THE CLINICAL LABORATORY AS A ROUTINE ADJUNT TO
THE HISTORY AND PHYSICAL EXAMINATION

Rationale[1]

"Classically there are three major avenues of gathering information with reference to patient management: the history, the physical examination, and the laboratory examination. The roles of the history and the physical examination have become relatively well established. The role of the laboratory examination is rapidly changing, however, and may be expected to change even more dramatically in coming years. It is now accepted practice to gather historical information and physical findings concerning all of the major systems of the body at the time of a detailed clinical examination. It will soon be feasible to provide a similar laboratory examination which will reflect information regarding many of the major systems of the body. Such a battery of tests will be directly analagous to the current screening type of physical examination which provides information regarding heart, lungs, liver, etc. Laboratory examinations of this type will be performed at the time of hospital admission, as well as during periodic health examinations. Information gathered from such examinations will be recorded in a form facilitating retrieval and will be helpful in detecting asymptomatic pathology, in facilitating earlier diagnoses, and in shortening periods of hospitalization. Data will be considered not only on the basis of what is normal in the general population, but what may be considered normal for an individual of a specific age and sex. In addition, compilation of such information will facilitate establishing normal values for given individuals. Values which could be considered normal in reference to norms based on the general population may appear abnormal when considered in reference to a patient's own established 'normal values'."

Summary of Findings of Several Recent Screening Studies:[2]

I. Glucose and diabetes mellitus.

A. Determinations of both blood and urine glucose concentration should be performed one hour after a "carbohydrate load".

B. A number of studies have shown that the average incidence of unsuspected diabetes is approximately 1.14% or 1 case of diabetes for every 100 people tested. (The number of undiagnosed cases of diabetes mellitus is probably equal to the number of known cases of this disease.)

C. False positive blood and urine glucose tests occur especially in young children and pregnant women.

D. Unsuspected abnormalities in blood sugar tests--2%, in urine sugar tests--6%.

1. P.E. Strandjord, Lab. Med.--A Prospectus, Minnesota Med., May, 1966, 773.
2. The data include only findings picked up as a direct result of the screening procedures under investigation.

II. Serum calcium and parathyroid function.

A. The incidence of unsuspected hyperparathyroidism is about 0.15%; hypoparathyroidism about 0.03%; and pseudohyperparathyroidism about 0.04%.

B. The incidence of unsuspected serum calcium abnormalities has been reported as being 0.96% or approximately 1 in 100 subjects tested.

III. Serum uric acid and gout.

A. Unsuspected gout--0.6%.

B. Unsuspected abnormalities in uric acid--4%.

IV. Kidney function tests and renal disease.

A. Unsuspected renal disease--0.5%.

B. Unsuspected abnormalities: BUN--1%, Cr--0.5%, Urine albumin--3.8%

V. Hemoglobin and anemia.

A. The incidence of unsuspected anemia is about 0.8%.

VI. Serologic test for syphilis.

A. The incidence of unknown syphilis is about 0.3%. (The incidence varies significantly in different areas of the United States.)

VII. Chest X-Ray.

A. Unsuspected pulmonary abnormalities--0.8%.

B. Unsuspected cardiac abnormalities--0.5%.

VIII. Blood pressure and hypertension.

A. Incidence of unsuspected hypertension--5%.

IX. EKG and heart disease.

A. Unsuspected heart disease of various kinds--3%.

B. 6 or 12 lead EKG is usually recommended.

X. Height, weight and obesity.

A. Approximately 6% of the population is overweight.

XI. Impaired Vision.

A. 16% of those tested are unaware they have faulty vision.

XII. Impaired Hearing.

A. Approximately 3% of the subjects tested are unaware of a hearing deficit.

The preceding outline mentions only some of the diseases and laboratory tests that have been studied. In most studies the incidence of unsuspected abnormalities is surprisingly high. Many of the people in these studies were considered to be well and healthy by themselves and by their physicians. Others may have been hospitalized during the study but not for the diseases or conditions that were discovered by the screening tests. In the majority of diseases or conditions discovered early diagnosis and early treatment are beneficial to the patient. Detailed information regarding the studies cited in this summary are presented in the following pages.

PLANS FOR ROUTINE LABORATORY STUDIES

AT THE UNIVERSITY OF MINNESOTA HOSPITALS

Test	I All Patients*	II Tests Selected on Basis of Findings in I	III Age & Sex Selected
Height and weight	X	---	---
Blood Pressure	X	---	---
Visual Acuity	X	---	---
Intra-ocular tension	---	---	X
Retinal Photography	---	---	X
Audiometry	X	---	---
EKG	---	---	X
X-Ray, Chest	---	---	X
X-Ray, Abdomen	---	---	X
Dental Screen	X	---	---
Blood			
VDRL	X	---	---
Glucose (after carbo. load)	X	---	---
Urea	X	---	---
Calcium	X	---	---
Sodium and	X	(Bicarbonate & chloride	---
Potassium	X	if Na or K is abnormal)	---
Cholesterol and	---	---	---
Triglycerides	---	---	---
Total Protein	X	---	---
Protein Electrophoresis	X	---	---
Uric Acid	---	---	X
Hemoglobin	X	---	---
White Blood Cell Count	X	---	---
Lactate Dehydrogenase	X	(LDH isoenzyme separation if LDH is abnormal)	---
Ornithine Carbamoyl Transferase	X	---	---
Alkaline Phosphatase	X	---	---
Acid Phosphatase	X	---	X
Urine			
Glucose (after carbo. load)	X	---	---
Protein	X	---	---
Microscopic Examination	X	---	---

*Expanded or deleted as indicated by clinical judgment and economic considerations. It does not include, at present, tests such as motor performance which would be selected on the basis of age and sex for pediatric patients.

ESTIMATE OF SPACE, EQUIPMENT AND PERSONNEL REQUIREMENTS

This list would be dependent on the equipment which is developed during the interim between August, 1966 and the time this laboratory is opened.

Space Requirements--Approximately 3,000 square feet

Equipment--Marked advances are occurring continually

Determination	Instrumentation	Man Hours/Day Based on 100 Patients/Day
Height and Weight	---	---
Blood Pressure	---	---
Visual Acuity	---	---
Intra-ocular Tension	---	---
Retinal Photography	---	---
Audiometry	---	---
EKG	---	---
X-Ray, Chest	---	---
X-Ray, Abdomen	---	---
Dental Screen	---	---
VDRL	Rotator $ 110	2
Glucose (Blood) & Urea	6,800	4
Calcium	8,300	6
Sodium & Potassium	2,200	4
Cholesterol & Triglycerides	9,000	6
Total Protein (Blood)*	5,000	2
Protein Electrophoresis	10,000	16
Uric Acid*	---	4
Hemoglobin	2,000	2
White Blood Cell Count	4,400	2
Lactate Dehydrogenase	10,000	4
Ornithine Carbamoyl Transferase	5,000	4
Alkaline Phosphatase**	6,800	4
Acid Phosphatase**	---	4
Glucose (urine)	---	
Protein (urine)	---	
Urine Microscopic Examination	800	4
Bicarbonate***	3,500	1
Chloride***	800	1
LDH Isozyme Fractionation***	3,000	4
SUBTOTAL (for Equipment Listed)	$77,710	74 Hours
Additional man hours to cover unforseen problems, reagent preparation, etc., 25%		18 Hours
SUBTOTAL (Man Hours)		92 Hours

* Employ Same Instrument
** Employ Same Instrument
*** Based on 20/Day

ESTIMATION OF EXPENSE OF BATTERY TO PATIENT

BASED ON SUBTOTALS ON PREVIOUS PAGE

Patient Number: (Estimate based on 100 patients per day, 5 days per week, 52 weeks per year with ten holidays) 25,000 patients.

Amortization of Equipment over Five Years: $16,000/year.

Personnel: Estimate $56,000/year.

Subtotal: $76,000/year per 25,000 batteries.

Tentative Conclusion: On the basis of these estimates and subtotal figures, it would appear feasible to charge about $15.00 per patient for this service. This is approximately the current price of a more limited battery in use at Duke University.