

# A NEW CONCEPT IN LABORATORY MEDICINE \*

## The Critical Care Laboratory

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### A New Concept in Laboratory Medicine

An increasing number of specialized intensive care units is being opened throughout the country. The existing ancillary services are rarely able to cope with the diversified needs of these new units and as a result, new forms of ancillary services must be developed or the old forms drastically altered.

The Clinical Laboratories providing critical ancillary service are hard pressed by the needs of intensive care units. The demands of an intensive care unit include twenty-four hour a day, seven days a week readily available lab work on all procedures that serve as an aid in treatment. All tests performed must be done with maximum assurance of accuracy and as fast as possible. In the past, clinical laboratories have served primarily in the diagnostic area of patient care; now, with the increase of intensive care units, it also must serve as a guide—and frequently the only guide—to immediate patient therapy. As a result, the type of procedures ordered by intensive care units is also different

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from the procedures ordered on routine floors. Such tests as blood gases are now being ordered not only by anesthesiologists and pulmonary specialists, but from all areas of the hospital.

In most hospitals the routine laboratories try to compensate for these new demands by arranging elaborate communication lines whereby a stat specimen is put on an auto-analyzer immediately and the answer read as soon as available. This method frequently is inadequate and delays over an hour in getting results are the rule. Occasionally, blood gases are being done on a departmental basis with each department responsible for its own patients. Almost always, this means blood gases are not available at night and when done, are being performed by house staff at a great loss of time and accuracy. A new form of laboratory is needed to cover adequately the demands of intensive care units and to prepare for future demands of large medical centers.

Hahnemann Hospital in Philadelphia has been pioneering a new concept in laboratories since June, 1970, and the results have been most rewarding in terms of expanded service to intensive care units and patient care in general.

The Critical Care Laboratory was opened concomitantly with a new Shock-Trauma Unit to meet the special demands of this unit as well as the other intensive care units at Hahnemann Hospital, namely, a Coronary Care Unit, Respiratory Intensive Care Unit (ICU), Surgical and Medical ICU's, a Pediatric ICU, Emergency Room, and a Neurosurgery ICU. The routine laboratories until June 1970, had been trying to cope with stat specimens as best they could, and blood gas determinations were being done by the Division of Pulmonary Diseases in the Department of Medicine. The Critical Care Laboratory was set up as a separate Division of the newly formed Department of Laboratory Medicine with essentially autonomous function. It was located close to the patient floors in an area easily accessible twenty-four hours a day, seven days a week.

### Tests Performed

The Critical Care Laboratory performs all tests deemed to be necessary for immediate management of a patient. "Immediate management" serves as the criteria for what is considered a stat. The tests at Hahnemann Hospital that are being ordered stat on this criteria and are hence being per-

TABLE 1

Tests Performed in Critical Care Laboratory

#### Chemistry

Blood Gases  
Total Carbon Dioxide  
Chlorides  
Sodium  
Potassium  
Blood Urea Nitrogen  
Glucose  
Calcium  
Amylase  
Total Bilirubin  
Salicylate  
Barbiturates  
Lactate  
Pyruvate  
Acetone

#### Hematology

Hematocrit  
Hemoglobin  
Leukocytes  
Differential  
Prothrombin  
Partial Thromboplastin Time  
Platelets

#### Special fluids

Protein  
Glucose  
Chromagen  
Differential

#### Urinalysis

Urine Pregnancy

#### Special tests

Cardiac Output  
Tissue  $pO_2$  and  $pCO_2$   
In-Vivo Arterial  $pO_2$  and  $pCO_2$

formed by the Critical Care Laboratory are listed in Table 1. All blood work is drawn by the physician or nurse and brought to the laboratory with a requisition slip which also serves as the patient charge slip.

The requested tests are performed and the results called back to the floor within fifteen minutes for blood gases and within thirty minutes for Chemistry, Hematology, and Urinalysis.

#### Equipment and Procedures

The equipment in the laboratory was chosen for speed, ease of use, reliability, and compatibility with disposable accessories. The procedures were chosen for accuracy, speed, as well as the ability to be semi-automated. The equipment and procedures are tabulated in Table 3.

#### The Staff

The staffing of the laboratory was probably the most crucial problem facing the newly formed laboratory. It was found that highly skilled technologists were needed who not only knew how to perform a given test, but knew the interpretation of the results so as to be better able to know when the results were not internally compatible. At present the laboratory has coverage completely by full time personnel, half of whom are registered American Society of Clinical Pathology (ASCP) technologists. This was accomplished by having each technician working a five day week but in no case Monday to Friday. For example, one girl has Sunday and Monday off, another Saturday and Wednesday off. This has worked very well and the technicians seem to enjoy the weekday off. This type of scheduling not only alleviates much overtime expense, but assures that weekend and evening requests are handled by professionals.

#### Organization

The organization of the Critical Care Laboratory includes a director who is a general surgeon with laboratory experience, an associate director who is an internist as well as consultants from the Division of Pulmonary Diseases, Hematology, Microbiology, and Chemistry, and a supervisor

who has laboratory training. There are five technicians working on each day shift; four technicians working each evening shift, and two technicians working on each late night shift. On each shift one technician is designated head tech and there is also one clerk and one secretary for day shifts and one clerk for evening shifts. This staffing provides for equalized services instead of the familiar poor laboratory work available evenings and weekends previously. It is also felt that the technicians working the Critical Care Laboratory enjoy a more rewarding job experience than their counterparts in the routine laboratories due to a feeling of being closer, and hence a more vital part of the patient care team.

If a problem should arise that is technical in nature, the supervisor is responsible for either remedying the problem or calling in service personnel for assistance. If patient problems should arise, the problems are directed to the laboratory director for appropriate action.

#### Financial Consideration

The Critical Care Laboratory as a business proposition has been surprising. From the opening of the laboratory in June, 1970 until September, 1970, the expense of purchasing initial equipment and the lack of proper controls on charge collection resulted in a large deficit. This was quickly recouped as the monthly income has risen in a little over a year. This increase in income is due primarily to the increasing number of blood gas determinations being done since the laboratory was opened but also reflects increased usage of other services. This type of charge collection eliminates any kind of duplicate billing and aids in collection from third party payers.

#### Utilization

One of the most important changes since the opening of the Critical Care Laboratory is the altered physician utilization of the lab. When STAT requests were handled by the routine laboratory, approximately 200 determinations were requested a day. In addition, an average of 10 blood gases were done a day by the Pulmonary

Disease Division of the Department of Medicine. As of April, 1972, the Critical Care Laboratory is performing over 500 specific determinations including approximately 40 blood gases a day. It is not felt this represents unnecessary STAT requests but rather that in the new ICU's, patient therapy is being based on laboratory results rather than laboratory results documenting that treatment was necessary.

#### Quality Control

Laboratory quality control for all procedures is monitored closely using internal quality control. External quality control is provided by the Institute for Clinical Science (F. W. Sunderman, M.D., Ph.D., President). In the past, quality control was rarely checked on the STAT procedures and was only done on routine procedures. This meant that the physician had to guess the degree and precision of a STAT result.

#### Research and Development

The types of determinations requested have changed as well as the number. Activated partial thromboplastin times are being performed in place of Lee-Whites' because of the improved accuracy as well as the technician's time saved by not having to go to the floors to collect Lee-Whites! Lactate and Pyruvate levels are being done frequently as an aid in monitoring shock patients. Blood gases are not only being ordered more frequently but special requests for simultaneous arterial-venous gases are being received, and the laboratory is then turning out reliable shunt percentages with the aid of a desk-top computer.

In addition to these changes, new procedures have been developed and incorporated into the laboratory as the needs arose. Spinal fluid xanthochromia is being quantitated as a more precise indicator for the diagnosis of subarachnoid hemorrhage. White cell counts and differentials are being done on amniotic fluids to aid in managing the obstetric patient and her fetus. In addition, two specialized procedures have been developed for the Shock/Trauma Unit: in-vivo tissue and blood gas monitoring by mass spectrometry

and computer calculated, dye dilution, cardiac outputs.

These procedures bring the laboratory to the patient and close the gap between a strictly medical or surgical procedure and a laboratory procedure. Our experience has been that there are many technical aspects of an Intensive Care Unit that are more easily handled by someone with laboratory training and at less loss of valuable physician time. The Critical Care Laboratory must remain flexible as

to be better able to cope with the ever changing demands of Intensive Care units and hopefully will strengthen the bridge between management of the actually ill patient and the routine clinical laboratories.

#### Summary

A new form of laboratory, The Critical Care Laboratory, is a necessary addition to any hospital that has or plans to have Intensive Care units. Its value to patient care is apparent

in that laboratory results can be used and relied upon before treatment is initiated and the efficacy of treatment is known more readily. The laboratory is also valuable financially as tighter control can be maintained in billing procedures. The sophistication in treatment of the acutely ill patient has made this type of laboratory valuable and the future can only serve to make more apparent the inadequacy of routine laboratories in serving these patients.

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## 7TH ANNUAL RESPIRATORY DISEASE SEMINAR

Sponsored by

TB & RD Association of Philadelphia and Montgomery County

On Thursday, October 5, the TB and Respiratory Disease Association of Philadelphia and Montgomery County and the Bucks County Tuberculosis and Health Society will sponsor the Seventh Annual Respiratory Disease Seminar. The Seminar will meet from 9:00 a.m. to 3:00 p.m. at the George Washington Motor Lodge, Route 611, Willow Grove.

Peter A. Theodos, M.D., will preside at the morning session and Katharine R. Sturgis, M.D., at the afternoon session.

#### PROGRAM

Registration ..... 9:00 a.m.

Coffee and pastry

Morning Session ..... 9:25 a.m.

Presiding: Peter A. Theodos, M.D.

Sarcoidosis: Etiology, Pathology and Treatment ..... Harold L. Israel, M.D.  
Treatment of Chronic Respiratory Insufficiency:

The Acute Situation ..... Leon A. Kauffman, M.D.

Psychological Aspects of Chronic Respiratory Diseases ..... Donald M. Lester, M.A.

Questions and Answers ..... 11:45 a.m.

Luncheon ..... 12:00 noon

Afternoon Session ..... 1:15 p.m.

Presiding: Katharine R. Sturgis, M.D.

Bacteriology of Pneumonia ..... Robert Austrian, M.D.

Surgical Aspects of Respiratory Care ..... Horace MacVaugh, III, M.D.

Questions and Answers ..... 2:45 p.m.

Adjournment ..... 3:00 p.m.

Reservations and requests for additional information should be directed to 279-7900 or TB-RD Assn., 1529 DeKalb Street, Norristown, Pa. 19401. Reservations for the seminar and luncheon must be made by Friday, September 29, and accompanied by a check for \$3.25 for each registrant, sent to the Norristown address.