For technologic and theoretical reasons the introduction of automation and computerization while improving the potential for communication has failed to increase the benefit/cost ratio of clinical laboratory services. It is suggested that a more effective use of available technology would occur by change of direction toward the development of computer controlled problem oriented clinical laboratory testing.

A decade of extensive-and expensive exploration and development has conclusively established that the combination of computerization and automation in the clinical laboratory can provide the physician with a large number of analytical results from a single small specimen in a relatively short time. Within reasonable limits the information can be supplied in whatever textual and graphic form that may be deemed most useful and from on line or off line sources at such intervals as may be desired. Further, as we had initiated some years ago, the evaluation of the physician can be facilitated by the simultaneous record of the earlier results of the same tests in the patient record. Thus by this "reasonability" or "delta" check a judgement can be made as to the direction and significance of change, if any, in a given parameter. The same information also gives the laboratory an opportunity to detect random error, the uncontrollable and unpredictable specimen handling and processing mistake which can uniquely invalidate a single test result in an otherwise satisfactory series of many samples.

As we reported at this Symposium a year ago, it has also been possible to utilize current technology to solve another vexing problem of clinical laboratory service, that of assuring the definitive linkage of the patient, the specimen and the information flow. Using light pen and laser scanning of bar coded patient and sample identification coupled with the transillumination transfer of human and machine readable information from patient identification cards or patient attached bracelets, it is feasible to eliminate the need for manual transcription of information from the time of the arrival of the patient in the hospital to the arrival of the laboratory results in the hands of the physician or in the patient record. The same general approach allows for an identified and verified linkage of the patient with required services such as the administration of blood, the provision of drugs and special diets, etc. It allows for the rapid, facile and inexpensive transformation of any document or container to one which can be machine identified. In this way, it expands the potential for the accelerating usage of minicomputers and microprocessors in distributed networks as an alternative to the expensive complexity of large central processors.

It was predictable that with a definition of the type of problems outlined above, with a reasonable knowledge of state of the art technology, coupled with reasonable funding and support, feasible solutions would emerge. But what else have we learned and in which direction are we to go in the future?

---- An Island by Itself?;-- There was a time--within our memory--when the laboratory corner of the hospital was terra incognita, an isolated place from which data emanated in modest quantity and in due time. The prevalent clinical attitude was that if the data did not fit the clinical picture it was probably in error and could be safely ignored. We have learned now that the imposing visual and auditory display of large automated equipment, CRTs, teletypewriters, printed and formatted reports carry their own mystique. Laboratory reports now may still be ignored for different reasons than above but are also too often accepted at face value without the consideration or mental effort that separates casual understanding- or misunderstanding- from perceptive utilization. The clinical
laboratory has moved into the clinical setting, a trend which will surely be enhanced by the increasing specificity of testing and its computer controlled correlation of clinical and laboratory information.

A simultaneous shift has taken place in the involvement of the clinical laboratory in the economic component of health care costs. With automation and computerization the unit cost of tests have decreased much faster than the charge to patients or third party medical providers. As a result hospitals have enjoyed a sharp increase in their excess of income over costs for the performance of laboratory tests. This provides a very significant source of support for non-self supporting education and patient services. Without doubt this income source has been unduly exploited by organizations and individuals. However the present government dictate that charges for any test or combination of tests be limited as a maximum, to a test "battery" in which they may be included appears to be universe. It has profound implications for the financing of medical care and the quality of clinical laboratory services.

Clearly the function of the clinical laboratory has broad clinical and economic ramifications for the totality of health care systems.

Is More Better?

At present, the clinical laboratory can provide a multitest battery on a single small specimen at a cost frequently as low as that of one or two separately performed procedures. This capability has evolved from continued technologic advance. It has been furthered by the expectation that increased clinical insight would be obtained by providing the largest possible number of test results. However with the accumulation of experience it has become evident that both these suppositions are seriously flawed both in theory and in practice.

Until now the development of multitest analytical equipment has focused upon the use of one or two detectors for the final analytical signal in a given instrument. Thus optimal analytical methods and detectors have not been utilized for the assay of individual constituents in the extraordinary complex mixtures which characterize human specimens. Instead, the analytical methods have been bent to conform to instrumental constraints. The result has been a loss of analytical precision and increased inaccuracy for many of the procedures usually included in a multitest battery. This analytical difficulty is compounded by the fact that considerable overlap occurs in normal physiologic variability with the reference intervals for the diseased state. A further difficulty arises from the lack of test specificity to distinguish between the normal and pathophysiologic state. It is not surprising that a large number of laboratory tests in a battery may be "outside the normal range."

The physician faced with this untoward product of technologic advance is in a difficult dilemma. If he ignores the aberrant result he may miss, for example, the correctly high calcium value of the patient with the quiet parathyroid cancer. On the other hand if he fully investigates the origin of the multitude of reported abnormal values the result has been shown to be a longer hospital stay of the patient at a high per diem hospital cost. "The High Cost of Low Cost Laboratory Testing" is a new reality.

A second basis for the effort to increase the number of tests in a profile battery has been the expectation that multivariate analysis would provide a key to the pattern recognition of the incipient or frankly pathophysiologic state. This has turned out to be an elusive goal. The background noise in the system increasing with the increasing number of unselected test parameters has obscured meaningful relations.

A Possibility?

Some years ago we proposed that online computer controlled laboratory testing with a multifaceted instrument be directed by a problem oriented iterative, heuristic process by which the patient history, physical findings and symptomology would be compared to the computer stored probability of disease. In this way, the maximum of useful test information would be available from the specimen at the time of its first examination. Such a process would have obvious implications for the shortening of patient hospital stay and reduction in cost consequent to the possibility of arriving at an earlier diagnosis and start of therapy. It may be that we are now approaching the time when such an effort can be contemplated.

Each of the subsequent presentations by my distinguished colleagues is complete in itself. Each provides an overview of the status of essential information needed to attain the goal of using computers to effectively direct clinical laboratory testing.