STRATEGIES FOR IMPROVING THE USE OF THE CLINICAL LABORATORY: COMPUTER APPLICATIONS

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Technological innovations including automation have made it possible for the clinical laboratory to provide, very rapidly, large quantities of data of high reliability. This circumstance contributes to a growing problem of effective use of clinical laboratory tests and data. This problem includes overuse and inappropriate use of tests and underuse of data. Strategies for improving the use of both tests and data, supported by computer techniques, are described and discussed.

I. Background

Utilization of health services is a public policy issue of foremost importance in the United States today. It is seen as a major contributor to escalating health care costs. In no area has utilization been more expansive than in the area of clinical laboratory services.

Rapidly expanding use of clinical laboratory services over the past two decades has a number of root causes not all of them clearly understood. A major cause, undoubtedly, has been the expanded technology of the clinical laboratory. New automated technology, including electronic data processing, has made it possible to provide a broad range of high quality analyses at a rapid rate. Often, notably in the case of multichannel screening analysis, the laboratory provides more information than the physician has requested. Furthermore old technology, replaced by new, is often not retired and the technology pool continually expands.

Technological advances, thus, have made possible a flow of information from laboratory to clinics and wards which is often too vast and complex to be utilized readily by the patient care team. At the same time, a gap has appeared and is growing between the laboratory and its complex technological array and patient care medicine. This situation manifests itself in overuse and inappropriate use of laboratory data.

A number of physicians, chiefly internists, have noted this state of affairs both in this country and Britain and have attempted to counteract it by educational measures. Notable among these are Griner and Liptzin, Schroeder, Ashley, Eisenberg, and Carter and his associates.

There is thus an urgent need to improve the use of the clinical laboratory in medicine and I believe computer technology can be used strategically in this task. The uses to which the computer can be applied fall in two broad areas:

1. Improved use of laboratory tests: diagnostic strategy and test selection.

2. Improved use of laboratory data: improving information content of data and improving use of data in clinical problem solving.

II. Improved Use of Clinical Laboratory Tests

In relationship to the use of the laboratory, the time honored method of arriving at a clinical diagnosis may have become somewhat eroded. In the clinical diagnostic method a careful history, physical examination and a few simple laboratory examinations were used to construct an initial hypothesis or hypotheses about the patient's illness. Laboratory analyses were then called up to confirm or exclude diagnostic hypotheses and the process of arriving at a final diagnosis proceeded in a linear logical fashion based on evidence obtained at each step along the way. The ability to provide an extensive array of biochemical analyses at the beginning of this process and along its path may have had a deliterious effect on the logic of test selection and test use.

Recently, McNeill and her associates, Schwartz and Gorry, Pauker and Kassirer and others have proposed the application of decision analysis, a process used in analyzing managerial decision and game strategy, to the process of making a clinical diagnostic or management decision. These efforts have been met with scepticism and criticism but may be successful means of improving the effectiveness of clinical laboratory use.

Similarly, diagnostic search and exclusion algorithms may be helpful as educational tools in test use and as aids to memory.

Bayes theory has also been proposed as a means of improving the logic of test use. This theorem, which states that the predictive ability of an observed quantity depends upon its "diagnostic specificity", "diagnostic sensitivity" and the prevalence of the condition being sought, has been used to evaluate the value of a test in a diagnostic decision. Tests of low "predictive value"
should be retired as being misleading and of low cost benefit.

III. Improved Use of Clinical Laboratory Data

A. Improved Background Information: The need for improved reference data for comparison with test data and strengthening their information content has been recognized. Is the maximum information being extracted from each test result? Decisional use of data is to some extent limited by inadequate and inappropriate reference data such as "normal values". Types of background information needed include: improved group specific norms; interday and interlaboratory analytical variance; patterns and amplitudes of temporal physiological variation; and conditional probabilities of diagnostic choices for a specific test result. Assembly of such data using computer techniques is in progress and will improve the usefulness of test data.

B. Predictive Values: Application of Bayes theorem makes it possible to take a probabilistic approach to the application of laboratory test results to a specific diagnostic problem. If one has determined the diagnostic sensitivity and specificity of a given test with respect to a suspected disease state and if one furthermore has a relatively good appreciation of the prevalence of the disease state in the population from which the patient comes, the conditional probability that the patient has the suspected disease can be obtained. Other important applications of this approach are relevant to screening and to the evaluation of diagnostic value of a given test, as was noted in an earlier paragraph.

C. Multivariate Analysis and Other Computer Strategies: A variety of computer techniques have been used to seek out relationships between test results. These techniques include: multivariate analysis, cluster analysis, trend analysis, and pattern recognition techniques. Research using these techniques may strengthen the interpretation of laboratory data.

D. Numerical Taxonomy: The process of discerning and defining new subgroups in well-recognized clinical classes such as a given diagnostic category of disease is one way that progress is made in clinical medicine. Multivariate and cluster analysis are now assisting in finding undetected subgroups of clinical significance. The value of this approach lies in the ability to identify and segregate subgroups which have prognostic and therapeutic significance.

E. Improved Reporting Modes and Schema: Information transmitted from laboratory to physician is interpreted on the basis of past experience available in memory and decisions are made. Faulty decisions may result from inadequate or incorrect information, faulty or inadequate interpretation or faulty or obscure transmission. Efforts must be made to transmit information in a manner which assures its acceptance and use.

A number of approaches are being made to improve data reporting. These often attempt to overcome such factors as inattention or rejection of key data. They also may act as memory guides and reinforcers in the cognitive process of decision.

An approach of this type is data compression by graphical display in a radial plot proposed by Williams. A number of individual investigators are proposing systems of reporting which attempt to overcome rejection of key results due to data overload by actively providing reminders of possible clinical conditions associated with key test results and other interpretative comments.

IV. Summary

A brief review of some ways in which computer technology can help to improve the use of the clinical laboratory in medical care has been presented. The emphasis has been on means by which improvements in the selection of laboratory tests can be made and on means by which test data can be used more effectively in clinical problem solving.

References


