

Automation in the Clinical Pathology Laboratory

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A large proportion of hospital pathology laboratories in the US were built or renovated in the 1960s or 1970s, and prevailing medical practice and the medical economics of the time led to common design themes. The forces felt by laboratory directors and managers today are considerably different from those that shaped the labs of the earlier era. A widening gap between what is desired from many laboratories and what they are physically capable of delivering is becoming increasingly apparent. The requirement for timely, accurate, well-communicated laboratory results is crucial. Approximately 70% to 80% of major clinical decisions are based, at least in part, upon information coming from the pathology laboratory.^{1,2} Thus, the impact of a successful laboratory on the efficiency and quality of care is far-reaching. Current pressures for design and process change include cost, turnaround time, the tightening technologist market, and reduction in clerical and preanalytical errors.

Cost

The advent of diagnosis-related group-based reimbursement for inpatients shifted hospital laboratories from revenue generators to cost centers. Since then, the requirement to reduce the cost of testing has been relentless.

Turnaround Time

The desire to reduce turnaround times stems from both the impact of rapid delivery of data-based therapy on outcomes in some circumstances (eg, chest pain and stroke protocols) and the drive to reduce hospital lengths of stay.

Tightening Technologist Labor Market

The average age of medical technologists is continuing to increase and, in some markets, as many as 84% of laboratories report that finding and hiring medical technologists is either difficult or extremely difficult.³

Reduction in Clerical and Preanalytical Errors

Recent years have seen increasing national awareness that a significant number of poor outcomes for hospitalized patients

are avoidable. Clerical and identification errors are responsible for a large fraction of such outcomes, and as many as 40% of errors occur during the preanalytical phase of testing. Reduction of human involvement in this process can result in improved patient safety, with fewer errors due to sample misidentification. Automation can also reduce sample processing time.

While our primary intention is to discuss automation in the clinical pathology laboratory, it must be emphasized that, ideally, implementation of automation should be coupled with process review. Automation often allows optimization of processes in ways that are not possible in a manual laboratory, and implementation of automation without thorough assessment of current laboratory processes is likely to result in missed

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opportunities. The flow of specimens and information and the activities of laboratory personnel should be examined with fresh eyes. Although this reevaluation may be difficult, it represents a crucial responsibility of the laboratory leadership, and everything should be put on the table. In particular, all preanalytical processing steps should be optimized to gain the full benefit afforded by automation. Container selection, specimen collection, specimen labeling, identification, receiving, and accessioning, and, ultimately, specimen tracking through the laboratory should be reevaluated. Autoverification of results, reporting methods, specimen retrieval for add-on testing, and ease of result interpretation are also vital considerations as processes are examined. Merely recapitulating the manual laboratory with machinery is not likely to reap the greatest possible benefits in efficiency and service improvement from the expenditure of resources.

Laboratory automation reduces the number of steps in testing requiring human intervention. When suitably implemented, automation reduces turnaround times for many tests. Automated systems do not reduce turnaround times by virtue of an ability to perform any individual step faster than a skilled technician does. Instead, these systems operate at or near maximum throughput up to capacity and do not suffer from potential lapses of attention. They allow a smaller number of skilled medical technologists to operate the instruments in a large laboratory. A specific example is the automated location and retrieval of specimens stored in a refrigerated stockyard for add-on testing. This does not require any human intervention, saves time, and avoids human error. With automation, the technologists expend a greater fraction of their time and energy on judgment tasks, making assessments and decisions that require their training and intelligence. Thus, the affect of the tightening labor market can be blunted.

The combination of automation and computerized interfaces has the potential to reduce the risk of clerical and identification errors. Primary sources of such errors are the preanalytical phase, the postanalytical phase, and, less commonly, any point in the analytical phase in which there is a hand-off from one person to another. Positive patient identification entails unique bar coding of the patient armband. Corresponding unique bar codes are printed at the bedside on specimen labels, which allow each specimen to be tracked during its travel through the automated system. Results are unerringly associated with the proper patient. In combination with a robust laboratory information system, this has the potential to drastically reduce errors, especially in the preanalytical phase of testing.

It is not clear a priori that the capital expenditure required to purchase the equipment to automate any individual laboratory will eventuate in an overall cost reduction. Moreover, the physical layout of some laboratories may not be amenable to large-scale automation. Thus, careful financial analysis must take into account current and projected specimen volumes, personnel costs based upon efficient management of laboratory staff, and the cost of the automation equipment and any required renovations of the laboratory space. Another factor that should be considered is that consistently short turnaround times may obviate a clinically relevant need for some types of point-of-care testing, which is usually manifoldly more expensive than testing within the laboratory.

In summary, the circumstances in which pathology laboratories now find themselves are very different from those that drove the design of a great fraction of laboratories decades ago. Laboratory automation can be a powerful tool to help many laboratories meet the challenges of the current environment and pressures. **NCMJ**

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