

SpaceMed Feature

Planning the Clinical Laboratory of the Future



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Background

The clinical laboratory was historically organized by testing methodology or discipline and the space was subdivided into numerous small rooms reflecting this organization. With the advent of multidisciplinary pieces of equipment, automated technology, robotics, and the demand for rapid results by clinicians, clinical laboratories are being functionally reconfigured by turnaround time as well as testing methodology. Laboratory managers who seek to reorganize clinical testing along these lines often find that the physical facility is a barrier to more efficient operations. Instead of compartmentalized space, contemporary laboratories need open, flexible space that easily accommodates new technology, allows staff to freely work among various pieces of automated, multidisciplinary equipment, and can be eventually converted to a totally automated laboratory.

In the past, the clinical laboratory was typically located on the main floor of the hospital, usually adjacent to the emergency department and surgery suite — two labor and technology intensive patient treatment areas. This location facilitated the convenient and rapid transport of laboratory specimens and results. With new advances in specimen transport systems, computerized results reporting, and the advent of point-of-care testing, this location for the laboratory is no longer necessary, nor is it advisable to locate it in “prime real estate” when its space is primarily used for specimen processing that does not require face-to-face patient interaction.

Moreover, as hospitals have aggressively formed networks and alliances in response to cost containment and competitive pressures, it became evident that not all hospitals could justify a full-service laboratory, nor was it deemed necessary.

As a result of market dynamics and technological developments, laboratories are being redesigned with more open, flexible space, often located in less-expensive space, but connected to the key patient care areas by a specimen transport system and with computer linkages to point-of-care laboratories.

Reorganization of the Clinical Laboratory By Turnaround Time

The hospital laboratory includes the two main components of clinical pathology and anatomic pathology. A third component — transfusion services (or the blood bank) — is responsible for the acquisition, storage, and preparation of blood products for infusion. Historically, these functions were performed next to each other but in distinctly separate areas of a large, central laboratory.

At a minimum, hospitals in the future will have a highly-automated core laboratory on-site providing rapid turnaround time that may be supplemented with point-of-care laboratories at key locations throughout the hospital complex.

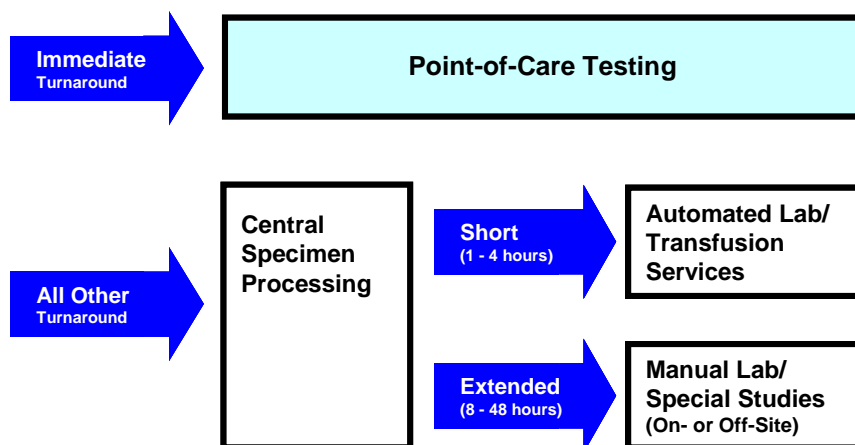
Regional reference laboratories (providing testing on specimens with a more lengthy turnaround time) may be developed to take advantage of new technology or specialized expertise. Reference work may be consolidated at a single location or divided between multiple hospitals to fully utilize existing space, staff, and equipment. For example, all microbiology testing may be performed at one hospital and all special chemistry testing at another.

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Reorganization of the Clinical Laboratory By Turnaround Time



New Facility Components

Traditionally, the clinical pathology component of the laboratory was organized by disciplines, such as hematology/coagulation, chemistry/urinalysis, immunology/serology, and microbiology/virology, which were physically separated. Instead, the clinical pathology laboratory of the future will be organized into the following facility components:

- **Central specimen processing.** This area will function as the central receiving, processing, and shipping area for all specimens except histology/cytology. Over time, central specimen processing will become fully computerized. Barcoded specimens will be received via a pneumatic tube system or by courier and automatically recorded and sorted. In addition, more instrumentation will use whole blood and have expanded menus so the amount of centrifugation and aliquoting (dividing samples) will be reduced. Specimens will be distributed to the automated laboratory or other testing areas from the central specimen processing area.
- **Automated laboratory.** This is a grouping of highly-automated instrumentation into one section of the clinical laboratory — centralizing the performance of all the high-volume testing in the disciplines of hematology, chemistry, urinalysis, and coagulation. This configuration allows significantly greater efficiency and faster turnaround time than would be achievable if each of these sections were separately located and staffed. The automated lab performs tests as soon as they arrive in the laboratory so there is no need for a separate “stat” lab when this configuration is deployed. In medium and large hospital-based laboratories, there may be automated instrumentation for processing specimens prior to loading them on the instruments. Preanalytic automation ranges from units that totally automate the processing of specimens to units that only automate some of the processing steps. Because this area will be operational 24 hours per day, the transfusion service or blood bank should be proximate to it. By grouping these services and tests, staff efficiency can be maximized, particularly on the evening and night shifts.

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- **Manual laboratory.** The manual laboratory would generally perform the chemistry, hematology, coagulation, and urinalysis tests that are left over after all of the automation has been centralized. Included in this area would be more hands-on types of instrumentation and procedures, such as osmometry, blood gases, manual differentials, and electrophoresis.
- **Microbiology.** The microbiology section in a small laboratory will typically perform only bacterial cultures. In a medium or large hospital-based laboratory, mycology, mycobacteria cultures (TB), and parasitology may be added. Mycology and TB can be performed in a separate enclosed negative-pressure room. Parasitology will be needed when working with patients who have been in a geographic location where parasitic infections are common.
- **Molecular pathology** uses polymerase chain reaction (PCR) methodologies, some of which require separation of operations into two or more rooms and may require specific ventilation requirements, such as negative-pressure. Molecular pathology testing will only be provided in larger laboratories.
- **Staff/administrative space.** Administrative, educational, and other staff support space should be located at the periphery of the laboratory, separate from testing areas, but still accessible to the staff.
- **Point-of-care testing (POCT).** As tests requiring immediate turnaround are shifted to the point of care, it is anticipated that hematology and chemistry testing in the main laboratory may be reduced over time. Although point-of-care testing facilities may need counter space for tabletop instruments or to store portable equipment used at the patient's bedside, most point-of-care testing in the future will be performed with hand-held instruments. However, space is still required within the central laboratory. The laboratory typically oversees the point-of-care-testing program — training nurses in how to perform the tests, monitoring the quality of the tests, and performing preventive maintenance on the equipment. The laboratory POCT coordinator will need both laboratory bench space and a clerical/computer workstation and file storage to manage the POCT program.

Although automation is evolving relative to histology and cytology, the functional organization of the anatomic pathology component is not expected to change significantly in the near future. A frozen section laboratory should be provided adjacent to the surgical suite for rapid examination of surgical specimens. From the frozen section laboratory, surgical specimens and cytology specimens will be sent to the anatomic pathology area of the laboratory for further analysis. Due to their separate specimen flow and analysis, it is not imperative that the clinical pathology and anatomic pathology components of the laboratory be located proximate to each other. Typically, the morgue is located in a remote area accessible to service vehicles.

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Summary

Increased automation of the clinical laboratory and the continuing shift to point-of-care testing with portable or hand-held instruments — either at the patient's bedside, emergency department, surgical suite, physician's office, or other ambulatory care settings — may reduce the number of laboratory staff required. The remaining staff will focus on quality assurance, quality control, and training. Laboratory managers will assume greater responsibility for cost-effective utilization of laboratory services. Therefore, central, hospital-based laboratories may require less space and a location in "prime" space will not be required.

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