Change in Clinical Labs in Hospitals

What Is a Clinical Laboratory?

Today’s clinical laboratory (lab) is one of a hospital’s largest departments and produces vital information for effective healthcare delivery. It contains discrete departments for a variety of lab test types and houses sophisticated specialized instrumentation. Although often viewed as an ancillary service, doctors rely heavily on fast, accurate tests for disease prevention, diagnosis, and treatment. In fact, estimates show that clinical labs provide about two-thirds of all objective information on patients’ health status (Coffman, 1998). This remarkable reliance on lab-based equipment for diagnostic testing increases dependency on various technologies. With improved intellectual process control and data management advances, the lab may become the most frequently used, and most important, source of diagnostic information in medicine (Felder et al., 1999).

In response to accelerating changes in the healthcare field, designers and clients have devoted a great deal of attention to creating flexible designs and furnishings in hospital-based clinical labs. Even so, the hypothesis that hospital labs require a high degree of flexibility has been essentially untested. In response, faculty from Clemson University, with support from the Coalition for Health Environments Research (CHER), embarked on a study to confirm or negate this claim (Battisto & Allison, 2003). An overview of the study is presented in the next section followed by design implications from research findings.

Research Questions, Methods, and Findings

The major objective of the study was to explore the nature and rate of change in clinical labs in community-based hospitals. Three primary research questions were:

1. What is the range of testing activities and human activities?
2. How does the lab use technology to support diagnostic testing?
3. How can the physical environment accommodate changes in specific tests, procedures, and uses of diagnostic technologies?

Both survey research and case study research were used to explore changes in clinical labs in a variety of hospitals. The key findings are organized into three areas: specific activities, technological processes, and physical environment.
Specific activities
Operational and process improvements are the primary motivators for changes in the types and quantity of tests. Hospital objectives include:
- Reducing turn-around times
- Improving quality
- Responding to changes in testing activities
- Responding to the availability of qualified staff
- Responding to changes in the location of patients

The volume and type of testing are constantly changing as hospital services grow, patient acuity increases, diseases are discovered or shift, and the healthcare system evolves. The test mix fluctuates daily, though there is an overall trend toward an increase in outpatient volume and decrease in inpatient volume. Today’s labs are doing more with fewer human and financial resources despite growing volumes. The majority (78%) of the labs reported volume increases in the past two years, and 70% anticipate a further volume increase in the next two years. Workload is growing due to:
- A shift of services to an outpatient setting
- Hospital growth
- A shift in patient demographics
- Joint ventures with outside labs
- Increased outreach activities
- Changes in core services

Technological processes
The second area of key findings is technological processes: the services, information systems, and automation technologies that operate the lab. Advances manifested in the equipment dictate the type, quantity, and speed of testing. The technological processes also determine the space and functional requirements needed to support the equipment. Almost 100% of labs surveyed expand their test menu at least once every two years. In addition, almost 90% of labs surveyed add new technologies and services at least once every two years.

Information systems also cause rapid change. As software becomes central to lab operations, technicians are forced to become information specialists in addition to medical technicians. Among labs surveyed, 91% added new or upgraded existing information systems in a five-year period. High-volume clinical
lab tests that require rapid turnaround times have become increasingly automated (e.g., chemistry and hematology). Automated testing areas (representing almost 75% of the testing volume) are the most susceptible to changes in technology, and consequently machines and services are updated frequently. In the past five years, 57% of labs surveyed added new or updated existing island automations.

Outside the core lab, technological advances are beginning to permit the cost-effective and efficient use of point-of-care testing. Nearly half (41%) of labs surveyed have satellite labs in the hospital; primarily in emergency departments, critical care, and surgery and ambulatory care.

The physical environment
The final key finding involves the physical environment: the place that supports activities and diagnostic testing. Changes to the physical environment in the lab are organized into three layers: infrastructure, space plan, and contents.

• Changes in lab infrastructure. The physical infrastructure of the lab (e.g., HVAC, electrical or lighting, plumbing, cabling) needs to support both the initial location and the relocation of equipment, and accommodate new equipment housing cutting-edge technologies. Since the clinical lab contains flammables, combustibles, high voltage, biohazards, and high technology, staff safety is a concern, and regulations are often stringent.

The majority (70%) of labs surveyed replaced, upgraded, relocated, or expanded one or more infrastructure systems in a five-year period, and 43% made changes to multiple units or the entire system. Preliminary findings suggest that changes made to ventilation systems, often mandated by evolving regulations, are most common in areas that deal with infectious diseases (e.g., microbiology, immuno-hematology), or use hazardous chemicals for testing. Although re-cabling occurs more frequently, the change is more disruptive and costly when HVAC systems and utilities are involved, since healthcare facilities are open year-round, 24 hours a day.

• Changes in lab space plan. Between 18% and 36% of the total gross square footage reported was involved in some type of space plan change. Renovating and relocating lab functions were the most common space plan changes reported. In a five-year period, 74% of the labs renovated their interior layout at least once, involving between 16% and 36% of the total lab space. In addition, 68% of labs relocated functions and/or departments at least one time during a five-year period, involving 11% to 27% of the total lab space.

Labs are taking down walls and creating open space to integrate lab areas. Expanding, moving, or building a new lab occurred less frequently, but several respondents noted that they are in the process of planning or completing construction of new clinical labs.

• Changes in the lab contents. The clinical lab houses an array of instruments, equipment, workstations, cabinetry, and supplies. Of all the changes investigated, purchasing, leasing, or relocating equipment are the fastest changes experienced by labs. In a five-year period, 90% of labs relocated multiple pieces of equipment at least once, and 97% purchased or leased new equipment at least once.
Changes made to the furniture follow the technological processes alterations since the layout of the furniture is dictated by equipment. Modifying furniture was the most common change made in this category, followed by adding furniture, and then consolidating furniture. Almost 90% of labs modified workstations, 66% added furniture, 62% consolidated furniture, and 44% replaced worktops. An average of all respondents reveals that more than 75% of lab furniture in the core lab is fixed or built-in, limiting reconfiguration of the lab. Lab staff reported a trend toward movable or modular furniture.

**Implications for Design**

1. The clinical lab should be organized into three flexibility zones (highly flexible, semi-flexible and least flexible) that correspond to technological requirements since the equipment is central to the function of the lab. Analysis of the workflow suggests that organizing the lab by technologies (e.g., automated versus manual processing), rather than by the traditional lab-specific departments, is essential. Clinical areas that primarily use automated systems (e.g., chemistry and hematology) along with central receiving and processing areas should constitute the **highly flexible zone**. This area would process the majority of routine testing and would account for approximately 75% of the testing volume. This area is also the most susceptible to change. The most frequently used automated systems should be physically located closest to centralized processing and receiving areas. A **semi-flexible zone** for special or esoteric testing areas would include semi-automated and manual processing. The open plan from the highly flexible zone must extend into the semi-flexible zone to accommodate equipment that spans lab areas. Offices should be located on the periphery in a **least flexible zone** to avoid workflow disruptions.

2. A lab needs an open plan to reevaluate and reconfigure furnishings, to support the dynamic, sequential movement of the specimen, and to remain operational as new technologies are added. The point of collection, the method of specimen delivery to the department (i.e., in person, by tube, or by automation), the patient affiliation with the hospital, and the types and methods of required tests are all factors of operational efficiency. Lab staff routinely eliminate physical barriers to improve workflow and improve efficiency. An open plan accommodates changes to instrumentation and correspondingly, to footprints and operational requirements. It is expected that software will change more frequently than hardware in labs, where information systems are independently integrated with equipment and interface with hospital information systems. Thus, access to data ports and electrical sources from various locations is mandatory.

3. Plug-and-play utility systems (such as overhead service carriers) should be included, particularly in the highly automated areas. Flexible power
supplies and data ports should be exposed and detached from structure and accommodate the location and relocation of instruments and equipment. The majority of clinical labs surveyed would like a non-restrictive utility infrastructure and are looking to teaching or research labs for successful models.

Infrastructure systems should include plans for additional capacity. The increasing density of technology in the highly flexible zone is causing more heat emissions, yet the equipment requires constant ambient temperatures. To satisfy codes and to ensure the safety and welfare of lab staff, HVAC systems should be planned in separate zones and planned for additional capacity allowing air quality to improve as testing procedures and methodologies evolve.

4. Modular furniture, adjustable height tables, and movable furniture are recommended so workstations can be removed or reconfigured as technological processes change. Modular furniture is a prerequisite to responding to rapid change. One lab staff said, “We are constantly adding instrumentation, moving and changing workspaces, so we need to gut the lab and get modular so we can easily shift work spaces around.” Survey respondents noted that it is critical to have furniture that can be easily changed in a timely manner with minimal disruption.

Conclusion
Lab staff are concerned that physical facilities in clinical labs are often disrupting service delivery. A coordinated effort by building owners, facility managers, and design professionals is necessary to create a clinical lab that will support multiple applications
over time. First, building owners must make big decisions about capital and operational costs and ensure consistently high quality results in a timely and cost effective manner.

The overwhelming thrust of the survey shows that facilities are changing rapidly. To remain competitive, building owners must recognize that the clinical lab is a major aid to medical diagnosis and failures in the clinical lab cause a compromise in care, a reduction in efficiency, and an increase in liability. Second, facility managers must make decisions that allow them to deploy equipment while ensuring the continuous operation of testing and services. Design professionals must create a flexible environment to accommodate current demands and future needs. They need to understand the forces of change that are affecting clinical labs and integrate those forces into their design solutions.

References:


Recommended Readings on Clinical Labs:


Other Recommended Sources:
—Clinical Laboratory Management Association <http://www.clma.org/>


About the Author
Dina Battisto, Ph.D., is an assistant professor in the Architecture + Health Program at Clemson University, one of only two professional degree programs in the nation with a concentration in Architecture for Health. Prior to joining faculty at Clemson, she worked as a senior management healthcare consultant in the areas of strategic planning, facility planning, and architectural programming.
Mulitdisciplinary Collaboration

The Coalition for Health Environments Research (CHER) is a not-for-profit corporation chartered “To promote, fund and disseminate research into humane, effective and efficient environments through multidisciplinary collaboration dedicated to quality healthcare for all.” CHER targets practical research useful to the creators of healthcare facilities and aspires to catalyze research and disseminate results on a national scale. It is led by a Board of Directors, a Research Council and a Provider Council. In its short history, CHER has initiated seven research studies, all created and peer reviewed by trained Ph.D.-level researchers. They include:

- Need for flexibility in clinical laboratories
- Role of color in health care environments
- Limiting the spread of infection in health care environments
- Identification of the differences between single and double bed rooms in acute care environments
- Evaluation of single occupancy NICU’s
- Identification of environmental factors contributing to nursing errors on acute care units

For more information, on CHER and CHER research studies, refer to the Web site at http://www.chersearch.org

Related Research Summaries

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“Reducing Discomfort for Microscope Users”
—Applied Ergonomics

“Work is Affected by Impact of Noise”
—Journal of Environmental Psychology

“Wayfinding in Large Hospitals”
—Environment and Behavior

“Designing for the Health Process”
—World Hospitals and Health Services

“Hospital Environments Elevate Stress Levels”
—The New England Journal of Medicine

“Adolescents Need Privacy in Hospitals”
—Journal of Pediatric Nursing

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