



FOCUS ON
HEALTH

Medical Technology

Self-study CPD activity

Activity Reference Number
L6(26) 2025

Topic

New Clinical Microbiology Laboratory

Article(s)

Practical Aspects and Considerations When Planning a New Clinical Microbiology Laboratory

Profession(s)

Laboratory Assistant, Medical Laboratory Scientist, Medical Technician, Medical Technologist, Supplementary
Laboratory Assistant Supplementary Medical Technician
Medical Practitioners

You can complete any one, or all the parts of this activity

Part 1 is approved for **THREE (3) Clinical** Continuing Education Units (CEU's)

Part 2 is approved for **THREE (3) Clinical** Continuing Education Units (CEU's)

Practical Aspects and Considerations When Planning a New Clinical Microbiology Laboratory



Dwight J. Hardy, PhD

KEYWORDS

- Microbiology lab • Lab design • Biosafety • Open floor plan • Shared space
- Flexible space • Lab infrastructure

KEY POINTS

- The scope and success of the new laboratory requires clarity and the combined vision of hospital, departmental, and laboratory leadership.
- You do not have to be an architect or a builder/contractor, but you do need to be able to clearly articulate specific space needs.
- An issue with open floor plans is to ensure that the space is not so cavernous so as to overwhelm our human need for feeling proportionate to and comfortable in the space.
- With the opportunity of new space, plan to locate equipment, instruments, and workstations for greatest efficiency gains depending on workflow and technical assignments.
- Do not assume anything, never be afraid to ask questions and challenge what you believe is incorrect.

So it's finally your turn. After what may have been years of discussions that often seemed to go nowhere, funding for a new new laboratory for your department has now been approved. You can only hope that the funding will allow for your current and future overall space needs, as well as correct long-standing problems that served to impede workflow and efficiencies. This article is written after more than 30 years of first-hand experience as a laboratory director working most of that time in "old" space with late twentieth century upgrades at best and more recently charged with planning for a new laboratory in an off-campus building undergoing renovations and expansion to accommodate a centralized laboratory for a growing health system. This review is not intended to replace detailed authoritative reviews on the topic of laboratory design and safety, but to put forward an experience-based user-friendly approach to thought processes and important points to remember for a successful new laboratory space.

Clinical Microbiology Laboratories, UR Medicine Labs, Pathology and Laboratory Medicine, University of Rochester Medical Center, Box 710, 601 Elmwood Avenue, Rochester, NY 14642-8710, USA

E-mail address: Dwight_hardy@urmc.rochester.edu

Clin Lab Med 40 (2020) 421–431

<https://doi.org/10.1016/j.cll.2020.08.015>

0272-2712/20/© 2020 Elsevier Inc. All rights reserved.

labmed.theclinics.com

PREPARATION

The first question a laboratory director or chief supervisor should ask is “what’s the scope of the project?” Are you planning a laboratory for a single or multiple hospitals? What menu and volume of testing will the new laboratory be required to perform to support the needs of the various hospitals with different specialty programs? Will the new laboratory support all inpatient and outpatient testing, or outpatient testing only? How many years will elapse between planning and occupying the new laboratory? For how many years to come will the laboratory be expected to serve the needs of the health system? How much annual growth should you expect over the next 5 or 10 or 20 years and are you allowed to plan for such growth? While you can participate in discussions aimed at providing answers to such questions, the combined vision and input of hospital and departmental leadership is mandatory. Likewise, if the centralized laboratory is “off-site” from 1 or more hospitals, it is necessary to have agreement on what testing capabilities will remain at the individual hospitals; distance from hospitals to the new central laboratory and frequency and dependability of courier service will be key factors in determining what testing remains at individual hospitals in the system. Without clarity on these issues, the end product, that is, the new laboratory, will likely not meet present and future needs of the organization.

Armed with answers to at least some of these questions, the next question is “where do I begin?” It’s time to prepare yourself for numerous meetings with laboratory administration, hospital space planning, contract space planners, architects, multiple project managers, and so on. While waiting to be introduced to members of the design and planning team identify the major players associated with the project, learn their names and roles and make sure that they come to know you. Plan to attend meetings of the various working groups assigned to plan for your area. If you show little interest in the overall project, decisions that will significantly impact your space and operation for years to come will be made without your input. If not already familiar to you, copies of key references that address important design issues should become part of your daily reading routine.^{1–3} Don’t be surprised if without consulting you, you are presented with a draft plan for your space and be prepared to offer rebuttal or alternate proposals; the quicker you are with your response to draft proposals the more seriously your proposals will be considered and the more willing planners may be to walk back from proposals that have already begun to take shape.

Early in the process of planning for new space, recognize that this is not a 1-person job and assemble your own team of supervisors and technologists who have a knack for identifying space needs, workflow problems, efficiencies, and solutions. Know your current space and what you need from new space, that is, more space, flexible space, better designed space for work efficiency, and so on (no one knows this better than you and your team). A good place to start is to look closely, dispassionately, and objectively at the space you currently occupy with an eye toward determining what’s good about it, what is OK but can be improved, and what is really bad and must change. Because you or someone unknown to you will be required to provide current square feet occupied, you should take careful accurate measurements of the space you currently occupy. You should take measurements of current laboratory space including obvious and not so obvious storage space, and areas frequently omitted by space planners, that is, hallways where freezers, refrigerators, and supply cabinets are currently stored, an extra closet space here and there that you may have acquired over the years but is not officially recorded in space surveys held by laboratory or hospital administration. Making this assessment and taking these measurements is not for the purpose of re-creating the space you currently occupy but to give you an idea of

overall current space needs. Indeed, in a new space which is better planned, your current and future needs may fit into a space that is smaller than you might predict (don't count on it, but it is within the realm of possibility).

With the opportunity of new space, plan to locate equipment, instruments, and workstations for greatest efficiency gains depending on workflow and technical assignments. Consider each and every bench top and floor-standing instrument and where it should be placed with input from technologists who perform the actual bench work of the laboratory for maximum operational efficiency and minimization of steps. Where possible, plan to colocate low-volume workstations that are the responsibility of a single technologist for enhanced ability to multitask and cross-cover. In times of shortages of licensed medical technologists, consider placing continuous monitoring blood culture instruments in preanalytical areas proximal to nonlicensed staff who may perform non-license-requiring activities, that is, load culture bottles, unload positive culture bottles, and unload negative culture bottles at the end of default incubation times.

ADJUSTING TO AN OPEN FLOOR PLAN

Be prepared to be presented with a vision for your laboratory space that is created by space planners and architects. The vision will likely be that of a large open space with movable work benches that offer flexibility and the ability to quickly respond to changing needs, for example, replace a movable bench with a floor model instrument in a day without requiring major renovations. Open floor plans can also enhance communication and cooperation among various work stations throughout the laboratory. For example, if anaerobic bacterial culture is a separate workstation it should be located near other workstations that have the greatest likelihood of having a companion anaerobic culture. Some disadvantages of large open floor plans, however, include noise and distractions from staff and instrumentation in adjacent areas, noise and distractions created by foot traffic from staff in proximal areas, and a general inability to adjust lighting and room temperature unless the ability for zone control of HVAC and lighting is included in the design to accommodate the comfort level of all staff. Unless you are able to successfully argue for a different approach to space design, a large open floor plan is likely the approach that will be used; after what may be an initial shock from seeing such a plan and the realization of how different it is from current space, consider the advantages of this design and how to mitigate the disadvantages of this design approach. A key issue with large open floor plans is to make sure that the space is not so cavernous so as to have the feel of a warehouse and overwhelm our human need for feeling proportionate to and comfortable in the space. With open floor plans, it is also important to consider the use of materials for walls, floors and ceilings that absorb noise and/or lighting to minimize distractions. In such designs it may also be necessary to implement a plan for traffic flow that minimizes distractions and the potential for laboratory accidents, for example, some areas may be open to all traffic, some areas open to 1-way traffic only and some areas may be "no thru traffic" to limit traffic to staff working in the immediate area only.

BIOSAFETY

In keeping with minimal safety requirements, clinical microbiology laboratories must be designed for working with biosafety level (BSL)-2 level pathogens and require strategically located biological safety cabinets (BSC) for primary specimen setup, conduct of aerosol-generating procedures and recognition of pathogens requiring higher safety level practices. To protect against laboratory-acquired infections and maintain

specimen integrity, laboratories should perform all primary specimen setup in a BSC. Separate from standard unidirectional flow of air from corridors into BSL-2 laboratory space (and from BSL-2 into BSL-3 spaces), which is a non-negotiable requirement, a design feature of the laboratory to be introduced to the planning team early in the process is the partitioning of Microbiology space from other laboratory areas.¹ The type of partition and the approach to partitioning depends on desired objectives. If not already part of the design team, Environmental Health and Safety (EH&S) should be a required participant in any and all discussions related to laboratory design and safety; if EH&S has not been invited to participate in such discussion, you should invite them. If the objective is to completely separate Microbiology's space from other laboratory areas in the event of an aerosol-generating laboratory accident, a separate and independent HVAC system is required along with sealed partition walls that cover from floor to deck (ie, the solid impermeable layer above the ceiling tiles). Although a partitioning wall can block airflow and light transmission between areas, glass or other light-permitting materials can not only prevent aerosol movements but can also allow for an open feel to the space and ameliorate a feeling of being "boxed in." It is noteworthy that a separate air handling system with walls from floor to deck adds significant cost to the overall project. If, however, the objective of a partitioning wall is to provide "some" protection against infectious aerosol movements from one space to another, a partitioning wall from floor to ceiling tile with an HVAC system that has easily accessible controls for shutting down airflow from the Microbiology Laboratory can be incorporated into the space design; this design can allow for a quick laboratory evacuation and may be a practical compromise for laboratories in which the likelihood of such accidents is extremely low.

Throughout BSL-2 laboratory areas include space for the placement of BSCs proximal to appropriate work areas, for example, specimen setup; for maximum worker safety, all specimens should be setup in a BSC with separate BSC for setup of sterile site specimens and nonsterile site specimens. Include a BSC for workup of positive blood cultures proximal to blood culture instruments (if inside the partitioned microbiology space) and instruments for molecular identification of organisms in positive culture bottles. For maximum worker safety, include BSCs throughout the laboratory for the examination and workup of cultures potentially growing agents of high-risk for laboratory-acquired infections and/or environmental contamination (eg, *Legionella pneumophila*, *Neisseria meningitidis*, *Brucella*, *Francisella*, *Burkholderia mallei/pseudomallei*, unsuspected molds, severe acute respiratory syndrome coronavirus 2 [SARS-CoV-2]) or handling of specimens requiring procedures with potential for aerosol generation. Although laboratory procedures have largely transitioned away from potentially toxic chemicals such as formalin and formaldehyde for safety reasons, any new laboratory should still have at least 1 chemical fume hood for current procedures as well as procedures that might be used in the future.

SPECIMEN RECEIVING

Within the brick and mortar of the clinical laboratory space, specimen receiving is where it all begins. Whether specimens are received by pneumatic tube systems, internal transporters, or external couriers, ample space is required for the registration and accessioning of specimens upon arrival in the laboratory. With regard to specimen receiving and accessioning for microbiological specimens, a distinct space for Microbiology Specimen Receiving (MSR) should be maintained recognizing that this function is a specialty area requiring dedicated and experienced staff. MSR can be safely located outside of the partitioned space defining Microbiology because

specimens remain in sealed containers preferably in individual zip-lock bags during log-in and accessioning activities. It is important for MSR to be proximal to or adjacent to where all specimens are delivered by couriers or pneumatic tube systems. Proximity to specimen receiving for other laboratory specimens and other preanalytical areas is also ideal when it comes to sharing clinical specimens, including but not limited to urine, body fluids and blood, and for sendouts to reference laboratories. Proximity to these receiving areas can be helpful for patient registrations that are required even before specimens for microbiology can be accessioned. When planning for MSR in laboratories, consideration should be given to locating automated blood culture systems in that area to allow preanalytical staff to load blood culture bottles immediately after receipt in the laboratory; culture bottles can be unloaded by preanalytical staff from the automated system when instrument-flagged positive and transferred to adjacent areas for workup by medical technologists.

SPECIMEN TRIAGE AND STAT TESTING

The next logical step for specimens from the MSR area is a triage workstation located within the partitioned microbiology laboratory space that should be immediately adjacent to MSR. Ample space for unopened specimen triage is important to directing specimens to a nearby STAT station or other routine processing stations deeper into the laboratory. A STAT workstation near specimen receiving with BSC(s) allows for rapid turnaround for procedures such as Gram stain, lateral flow immunochromatographic tests (ie, for detection of human immunodeficiency virus, malaria, *Legionella*, *Streptococcus pneumoniae*, *Clostridium difficile*), and molecular instrumentation for detection of a variety of infectious agents, including but not limited to influenza virus, respiratory syncytial virus, SARS-CoV-2, methicillin-resistant *Staphylococcus aureus*, *C difficile* toxin, and Group A *Streptococcus*.

SPECIMEN SETUP: BACTERIOLOGY AND MYCOLOGY

It may be efficient to perform manual setup of bacterial and fungal cultures in the STAT area with incubation of inoculated media in the same area or transfer of inoculated media to the inner laboratory for incubation. All specimen setup should be performed within BSCs and consideration should be given to providing separate BSCs for setup of sterile site specimens versus nonsterile specimens. If design of new space presents opportunity for installation of a total automated system for culture setup, incubation, and workup, complete specifications of the automated system should be given to space planners at the earliest possible time. Furthermore, vendor experts should be in personal communication with space planners to ensure that the space is appropriate to precisely accommodate large and expensive equipment with fixed and very specific power and information technology (IT) needs to avoid costly design missteps.

VIROLOGY AND MOLECULAR MICROBIOLOGY

Over the course of a few short years, testing for viruses has transitioned from a tissue culture-based laboratory with dedicated technologists highly trained in the specifics of tissue culture and cytopathic effects to a largely molecular operation. This includes manual “open” laboratory-developed molecular tests requiring expertise in nucleic acid extraction, amplification and detection to commercially available “closed” molecular test platforms that require general but little specific knowledge of targeted viral agents. Instrumentation performing molecular testing for many viruses is not specific

to virology and is often placed the STAT area of the microbiology laboratory for rapid testing on a 24/7 basis. Routine molecular testing for other viruses, such as those causing gastrointestinal disease, is also included in test platforms not specific to virology, that is, platforms that detect bacterial, parasitic and viral agents, that can be placed in areas of the microbiology laboratory convenient for cross-coverage by technologists from other subdisciplines of microbiology. When locating test platforms for any infectious agent recall that the maximum promise of molecular technology is achieved only when these platforms are not powered down and locked up at the end of the day shift, which means such test platforms should be convenient to evening and night shift personnel.

Other high-volume molecular tests such as for the detection of agents of sexually transmitted diseases can be located in areas of the laboratory that serve best advantage for efficiencies, cross-coverage, and testing on different shifts. Molecular tests for viruses that are performed on platforms used only for the detection of viral agents can be colocated in areas of the laboratory where there is advantage for cross-coverage and other efficiencies. These examples serve to illustrate that with the introduction of commercially available “closed” molecular amplification test systems, testing for some infectious agents can be located in discipline-neutral areas of the microbiology laboratory as long as content experts are readily accessible and supportive equipment, for example, BSC, is conveniently located and provided in quantities necessary to meet the test volume need. It is also important to emphasize that per current Centers for Disease Control and Prevention guidelines and recommendations, the processing of specimens for routine SARS-CoV-2 diagnostic testing can be safely performed in BSC within a BSL-2 laboratory by staff trained in sterile technique and practices requiring careful and nimble manipulations. Although molecular test platforms may be located in different areas of the clinical laboratory, the example of SARS-CoV-2 underscores the importance of locating molecular tests for diagnosis of infectious diseases with the content experts in clinical microbiology.

The introduction of commercially available Food and Drug Administration (FDA)-cleared products and test platforms for molecular amplification of an ever-growing list of infectious agents has reduced the need for “PCR suites” in clinical microbiology laboratories with 1-way traffic and separate rooms dedicated to reagent preparation, extraction, amplification and amplicon detection which are all part of open laboratory-developed tests. The experience of Coronavirus Disease 2019 (COVID-19), however, reminds us that the availability of such space is one factor that allows for the rapid creation and implementation of laboratory-developed tests where commercially available FDA-cleared tests do not exist. Not all laboratories may need such space, but, larger regional laboratories and academic-based laboratories should consider including such space in planning for new facilities.

MYCOLOGY AND MYCOBACTERIOLOGY (SECTIONS WITH BIOSAFETY LEVEL-3 CONSIDERATIONS)

From what might be described as a central or core BSL-2 laboratory space, an adjacent space or suite for separate BLS-3 laboratories for mycology and mycobacteriology can make for good workflow patterns. A single anteroom off of the core BSL-2 laboratory with separate entry into separate laboratories for mycology and mycobacteriology can save space. The need for separate spaces for these specialty areas depends on the type of laboratory and patient populations served by the laboratory. Laboratories that only culture yeasts may not need BSL-3 mycology space, whereas laboratories that culture specimens from severely immunocompromised patients at risk for spore-forming molds

such as *Histoplasma* and *Coccidioides* and workup such cultures require BSL-3 space. Similarly, laboratories that serve severely immunocompromised patients at risk for mycobacterial infections, including *Mycobacterium tuberculosis*, require BSL-3 level space. The design of BSL-3 space should strictly adhere to efficient workflow and recommendations for required square footage per person so as to prevent crowding, which may lead to laboratory accidents.¹ Include space for as many BSCs as required to safely perform work and keep “dirty” procedures, for example, processing and decontamination of specimens, from “clean” procedures, for example, culture workup. Positioning these 2 laboratories in adjacent spaces allows for cross-coverage of those laboratories and can also make for the efficient location of separate double-door autoclaves in each laboratory that empty into a common discharge area.

SEROLOGY

Serologic testing for antibodies/antigens of infectious agents and for markers of autoimmune diseases use bench top test platforms or large floor model instruments. Bench top platforms using enzyme-linked immunosorbent assay technology require places for microplate setup, plate washers, plate readers, and other standard small equipment, such as vortexers, water baths, centrifuges, and PC work station, which when taken in totality can require more than 6 feet of linear bench. If possible, equipment common to such workstations should be placed between or proximal to test setup for different assays to share the equipment and avoid duplication of equipment (although some redundancy in equipment is desired). Larger floor model platforms should be placed such that equipment has sufficient “breathing” space and can also be accessed from sides and back for maintenance and repairs; these large high-volume instruments should be directly connected to distilled/deionized water as needed and be proximal to floor drains for waste drainage. When positioning any of these platforms, consideration should be given to cross-coverage by technologists for maximum efficiencies. Storage space for liter or larger quantities of buffers and reagents for these platforms should be nearby.

Serologic testing follows the same testing guidelines for all BSL-2 activities. Splash/spray of specimens when uncapping specimen tubes is a major concern for avoiding laboratory-acquired infections. Providing ample bench space with fixed or movable splash guards or BSC (as deemed necessary) and centrifuges with containment for specimen preparation and test execution is sufficient per current safety recommendations. After specimen centrifugation in closed containers, testing with large floor model instruments provides containment for actual testing and has the advantage of waste drains that empty directly into floor drains for minimizing contact with potentially infectious material.

After years of performing fluorescent or dark-field microscopy in sub-standard inadequate space be sure to plan for a room to house fluorescent microscopes within the BSL-2 laboratory space. For efficient use of space, include microscopes to examine fluorochrome stains for mycobacteria, calcofluor stains for fungi, immunofluorescent stains for viruses, and immunofluorescent stains for markers of autoimmune diseases (eg, anti-nuclear antibody, antineutrophil cytoplasmic antibody). Locating microscopes for these various stains in the same room can succeed if different work groups can “play well together” and schedule nonconflicting times during the workday for use of the room.

SHARED SPACES

A feature frequently incorporated into new laboratory design is that of “shared” space. If you’re told that freezers that will not require daily or frequent access will be stored in

a shared “freezer farm,” be sure to make your space and electrical needs known and argue for the location of such shared space to be proximal to the laboratory. Similarly, if you’re told that shared storage space for dry goods and items, including test kits, which can be stored at room temperature is incorporated into the new design, be sure to make your needs known and argue for location of such shared space to be proximal to the major laboratory sections. For refrigerated items, the strategic placement of floor model refrigerators throughout the laboratory for storage of small items near point-of-use is certainly advantageous. Be prepared, however, to argue that individual floor model refrigerators do not substitute for walk-in cold rooms. Refrigerated storage of commercially prepared media used in high volumes and large boxes/cartons of test kits do not fit efficiently into floor model refrigerator units. Involve individuals from Supply Chain in this discussion because they will likely be responsible for stocking, inventory management, and transport of supplies from cold rooms, which should be immediately accessible to point-of-use areas within the laboratory. If Supply Chain or Inventory Management is not involved in the laboratory design process from the outset, be sure to bring them into the discussion and invite them to meetings early in the process to ensure adequate and proximal storage space; it’s unfortunate, but architects and planners may be more likely to listen to Supply Chain than to you when planning for storage space. The experience of COVID-19 and its impact on supply chain disruptions documents the failure of just-in-time delivery for basic laboratory products and the need for ample space to store routine and esoteric items necessary for operation of laboratories in “normal” times and in times of epidemic/pandemic outbreaks. Shared space can also include space for waste storage, which is often overlooked and underestimated; left to nonmicrobiologists, space for waste storage will likely be insufficient for weekends and holiday weekends when waste pickup is less frequent. Another aspect of shared space can also include space for record retention and storage.

TEACHING AND TELEMEDICINE

Designing and building a new laboratory provides an opportunity to include adequate and appropriate space for teaching. The kind, amount, and design of teaching space required by an individual laboratory depends on several factors, including the different categories of students and/or trainees, the number of students in each category and the nature of the teaching required to satisfy the learning experience for each category. For example, space needs for teaching students of medical technology may require a classroom for the delivery of didactic lectures and a space to perform microscopy and wet laboratory exercises, which is separate from the space where routine clinical work is performed. Another example of teaching by a clinical laboratory in terms of space needs includes “shadowing” of experienced technologists by newly hired technologists or residents from different specialties in which the required educational experience can be achieved by observation; such teaching may be accommodated at existing work benches in the clinical laboratory or may require an additional “teaching bench” within the footprint of the clinical laboratory, but does not require a classroom or separate wet teaching laboratory. Although different from in-person teaching, recent experience with COVID-19 has demonstrated that the clinical laboratory must also provide a learning experience to off-site participants including students, attendees of clinical rounds and medical conferences, and staff of affiliate laboratories by remote transmission (eg, Zoom) of lectures, case presentations, and plate rounds with still or real-time high-resolution macroscopic and microscopic images⁴; such technology can also be used by affiliate laboratories to transmit images to a core

laboratory for review by more experienced central laboratory based technologists.⁵ The IT needs for remote teaching from the clinical laboratory may be met by software on personal computers available in an office or conference room. Similarly, the clinical laboratory should have a sufficient number of small and large conference rooms that can be shared by all laboratory disciplines and that can accommodate the receiving of remote seminars, clinical rounds, and conferences for the educational experience of laboratory faculty and technologists.

GENERAL CONSIDERATIONS

When planning for a new laboratory, it is important to consider the number of required work benches and what constitutes appropriate space per bench. It is not unreasonable to plan for a minimum of 6 linear feet of bench top per designated workstation with 1 or 2 shelves of similar length above the bench and shelf/drawer unit below the bench for storage of protocol binders and materials required for that workstation; locate benchtop equipment such as centrifuges and microscopes on 6-foot benches proximal to where needed. Also include separate and dedicated bench/desk areas for the performance of quality control (QC) activities required for new lots and shipments of media and test reagents/kits, quality assurance activities, special projects; if need in the area of QC, including media assessment and preparation, is sufficiently large a separate room adjacent to the core laboratory may be warranted. As you plan for the workspace, make sure to include sufficient number of electrical outlets for required equipment and ancillary devices (eg, computer/keyboard/barcode scanner; monitor; computer printer; label printers for Laboratory Information System (LIS), antimicrobial susceptibility testing (AST), and total laboratory automation (TLA) systems; bench top lamp; electric incinerators for sterilizing loops; heat block; vortex; slide warmer;) because each workstation can have 5 to 10 devices requiring electricity; request that electrical outlets be placed to the left and to the right side of the bench to avoid long electrical cords or use of extension cords spanning across the work bench. Similarly, include sufficient number of IT ports for each workstation (eg, computer, printer, label printers, other ancillary devices) and instrument remote access. Don't forget to include IT connection for phone at each workstation requiring a phone. Does your laboratory use natural gas for sterile flaming? Does your laboratory operation require in-house vacuum and/or in-house deionized or distilled water connections? Remember that the cost to install electrical outlets and IT ports for computer, telephones, printers, ancillary devices, as well as natural gas jets, vacuum jets, deionized or distilled water connections is significantly less (a fraction of the cost) when installed at the time of construction versus after construction is complete. Indeed, it may not be possible due to infrastructure challenges or cost to install new or additional electrical outlets, IT drops, water or gas connections, and/or plumbing drains after construction is complete.

When planning for equipment, instruments, and people, remember to consider temperature requirements for optimal operation and function (and this includes people). Where practical and possible attempt to incorporate independent temperature zones for individual comfort and instrument/equipment performance. Computerized and distant temperature monitoring of spaces and instruments relieves laboratory staff from manually monitoring and recording of such information and is a desired feature in any new space.

Be sure to include strategically located clean and dirty sinks throughout the laboratory, as well, as hand-washing sinks near exits to encourage frequent hand washing and overall good and safe hygiene practices. For instruments that require distilled

or deionized water for reagent mixing, have water lines placed proximally. For maximum flexibility, have floor drains placed proximal to the planned placement of instruments that have waste drains to avoid having to lift and empty large carboys of waste water/reagents/specimens into dirty sinks causing splashing and injured backs; for greatest flexibility have additional floor drains placed throughout the laboratory in the event space needs change and equipment needs to be moved.

Planning for new laboratory space may allow for the incorporation of long sought after instruments and platforms that current space was unable to accommodate. Don't forget to plan for these needs because the opportunity for additional space may not come around again anytime soon. For something as large and complex as a total automated platform for setup, incubation, reading, and workup of cultures be sure to bring together the system manufacturer with building project management and electrical consultants to hear first-hand of specific needs and requirements; don't leave the placement and infrastructure support of such a large, complex, and expensive system to "middle men" communicating to content experts via e-mail.

Be prepared to provide copies of electrical and IT specifications/requirements for each instrument in the laboratory. Although generally obvious that differences between 110 V versus 220 V must be taken into account, differences between plug configurations on each instrument must also be taken into account. Keep copies of all information you provide to planners, architects, and project managers because you will likely be requested to send the same information to other individuals or requested to re-send the same information to the same individuals. All new construction should include provision of normal electrical power, as well as emergency backup power. It would be simple and easy to say that all laboratory equipment, instruments, and workstations require emergency electrical backup power. Because that approach may be cost prohibitive to some projects, consider each instrument, each workstation, and each piece of equipment to determine whether it is imperative for the real-time delivery of patient care and employee safety. In brief, all instruments and systems absolutely required for patient care and employee safety should be on emergency electrical backup, for example, all continuous monitoring blood culture incubators/cabinets and controllers, instrumentation required for delivery of STAT testing for inpatients and emergency department patients (think influenza virus testing), all BSCs and all fans responsible for maintaining negative pressure in laboratory spaces. In addition, a significant number of PCs with ancillary devices connecting to LIS (but not necessarily all) should be on emergency electrical back, where duplicate instrumentation exists for high-volume non-STAT testing (think sexually transmitted disease testing) 1 of 2 or more instruments should be considered for backup power, whereas pencil sharpeners do not require such backup. Each laboratory needs to develop a conscious plan that takes into account every piece of equipment and balances needs versus cost. Some new construction also includes electrical line conditioning for the entire building, which combined with facility-provided emergency power backup, can obviate the need for an individual Uninterruptible Power Supply (UPS) connected to each large instrument in the laboratory. Consult with the project managers and electrical consultants to determine the precise specifications of what your facility will provide. If the building provides dependable instantaneous electrical backup and continuous line conditioning, why clutter floor space with unnecessary UPS that will just attract and trap dust bunnies?

Last, office space for directors, supervisors, and support staff specific to clinical microbiology should be immediately adjacent to the laboratory to make for easy first-hand observations and communication with technologists. Locating offices in nonadjacent areas will result in delayed or lost opportunities for positively impacting

patient care. In addition, locating offices immediately adjacent to the laboratory allows for directors and supervisors to be visible, available, and accessible to technologists and assists in improving overall staff satisfaction and performance.

DISCLOSURE

The author has nothing to disclose.

REFERENCES

1. Miller JM, Astles R, Baszler T, et al. Guidelines for safe work practices in human and animal medical diagnostic laboratories. Recommendations of a CDC-convened, Biosafety Blue Ribbon Panel. *MMWR Suppl* 2012;61(01):1–101.
2. Doern CD, Holfelder M. Automation and design of the clinical microbiology laboratory. In: *Manual of clinical microbiology*. Washington, DC: ASM Press; 2015.
3. CLSI. Laboratory design. In: *CLSI standard QMSO4*. 3rd edition. Wayne (PA): Clinical and Laboratory Standards Institute; 2016.
4. Pentella M, Weinstein MP, Beckmann SE, et al. Impact of changes in clinical microbiology laboratory location and ownership of the practice of infectious diseases. *J Clin Microbiol* 2019. <https://doi.org/10.1128/JCM.01508-19>.
5. Martinez RM. Remote technical review of blood culture gram stains at a large integrated healthcare network. *J Appl Lab Med* 2019;3(4):733–4.

QUESTIONNAIRE

L6(26) Part 1 of 2

Practical Aspects and Considerations When Planning a New Clinical Microbiology Laboratory

INSTRUCTIONS

- Read through the article and answer the multiple-choice questions provided below.
- **Some questions may have more than one correct answer;** in which case you must mark **all** the correct answers.

Preparation

Question 1: What is one of the first questions a laboratory director should ask when planning a new laboratory?

- A:** What is the budget for equipment?
- B:** How many staff members are needed?
- C:** What's the scope of the project?
- D:** Where will the laboratory be located?

Question 2: Whose combined vision and input are mandatory for providing answers to foundational planning questions? The.....?

- A:** Design and planning team
- B:** Hospital and departmental leadership
- C:** Laboratory director alone
- D:** Supervisors and technologists

Question 3: When planning for a new space, who should be assembled to form the director's own team?

- A:** Contract space planners and architects
- B:** Members of hospital administration
- C:** Non-licensed staff and couriers
- D:** Supervisors and technologists who have a knack for identifying space needs

Question 4: What is an important early preparation step when planning a new laboratory?

- A:** Start ordering equipment
- B:** Design the floor plan
- C:** Take measurements of current space
- D:** Hire new staff

Adjusting to an Open Floor Plan

Question 5: According to the text, what is a primary advantage of an open floor plan?

- A:** It guarantees lower construction costs
- B:** It can enhance communication and cooperation among various workstations
- C:** It allows for individual temperature and lighting control
- D:** It naturally reduces noise from instrumentation

Question 6: What is a key consideration when implementing an open floor plan?

- A:** The space should have maximum ventilation
- B:** The space shouldn't be too cavernous
- C:** The space should have multiple exits
- D:** The space should be brightly lit

Question 7: How can noise and distractions be mitigated in an open floor plan design?

- A:** By ensuring all staff use headphones
- B:** By creating smaller, enclosed work pods
- C:** By using materials for walls, floors and ceilings that absorb noise
- D:** By playing ambient music to mask other sounds

Biosafety

Question 8: What is a non-negotiable requirement for biosafety in laboratory design?

- A:** Multiple exits
- B:** A separate HVAC system
- C:** Unidirectional flow of air from corridors into BSL-2 laboratory space
- D:** Glass partitions

Question 9: What is required if the objective is to completely separate microbiology's space from other laboratory areas in case of an accident?

- A:** A partitioning wall from floor to ceiling tile
- B:** An HVAC system with easily accessible controls
- C:** Glass partitions to maintain an open feel
- D:** A separate and independent HVAC system along with sealed partition walls

Question 10: While many toxic chemicals have been phased out, what should a new laboratory still have for current and future procedures?

- A:** At least one chemical fume hood
- B:** A dedicated chemical storage room
- C:** Specialized ventilation for chemical fumes
- D:** An emergency chemical shower at every workstation

Laboratory Sections & Workflow

Question 11: Why can Microbiology Specimen Receiving (MSR) be safely located outside of the partitioned microbiology space?

- A:** Because the area has its own independent air supply
- B:** Because only non-infectious specimens are handled there
- C:** Because specimens remain in sealed containers preferably in individual zip-lock bags
- D:** Because all MSR staff are required to wear full personal protective equipment

Question 12: Where should Microbiology Specimen Receiving (MSR) be located?

- A:** Inside the BSL-3 area
- B:** Proximal to or adjacent to where specimens are delivered
- C:** In a separate building
- D:** Within the main laboratory area

Question 13: Where should the specimen triage workstation be located?

- A:** In the same area as the MSR outside the main lab
- B:** Within the partitioned microbiology laboratory space, immediately adjacent to MSR
- C:** Deeper into the laboratory to keep it separate from STAT testing
- D:** Near the laboratory director's office for oversight

Question 14: What is required for specimen setup in the laboratory?

- A:** Multiple workstations
- B:** Biological safety cabinets (BSCs)
- C:** Special ventilation
- D:** Automated systems

Question 15: What should be done at the earliest possible time if a total automated system for culture is being installed?

- A:** Staff should be sent for training on the new system
- B:** The existing manual workstations should be decommissioned
- C:** A cost-benefit analysis should be presented to leadership
- D:** Complete specifications of the automated system should be given to space planners

THE END

QUESTIONNAIRE

L6(26) Part 2 of 2

Practical Aspects and Considerations When Planning a New Clinical Microbiology Laboratory

INSTRUCTIONS

- Read through the article and answer the multiple-choice questions provided below.
- **Some questions may have more than one correct answer;** in which case you must mark **all** the correct answers.

Question 1: What has changed significantly in virology testing over recent years?

- A:** Increased manual testing
- B:** Transition to tissue culture-based testing
- C:** Transition to molecular operation
- D:** Decreased automation

Question 2: When is the maximum promise of molecular technology achieved?

- A:** Only when these platforms are not powered down and locked up at the end of the day shift
- B:** When the tests are performed exclusively by virology content experts
- C:** When platforms are located in a discipline-neutral area of the laboratory
- D:** When open, laboratory-developed tests are used instead of closed systems

Question 3: What is recommended for BSL-3 laboratory space design?

- A:** Maximum occupancy
- B:** Efficient workflow and required square footage per person
- C:** Multiple entry points
- D:** Shared workspace

Question 4: What is a major safety concern for avoiding laboratory-acquired infections during serologic testing?

- A:** Splash/spray of specimens when uncapping specimen tubes
- B:** Aerosol generation from microplate washers
- C:** Direct contact with reagents and buffers
- D:** Contamination from floor model instruments

Question 5: What factor allows different work groups to successfully share a single room for fluorescent microscopy?

- A:** Having identical microscope models for all procedures
- B:** Installing high-efficiency particulate air (HEPA) filters
- C:** If different work groups can "play well together" and schedule nonconflicting times
- D:** Storing all stains and reagents in a separate, dedicated area

Shared & Ancillary Spaces

Question 6: Why are walk-in cold rooms considered necessary even if floor model refrigerators are available?

- A:** Because high-volume media and large test kit boxes do not fit efficiently into floor model units
- B:** Because floor model refrigerators cannot maintain the required low temperatures
- C:** Because walk-in rooms are required by supply chain management protocols
- D:** Because floor model units are less energy efficient than walk-in rooms

Question 7: What is the likely outcome if space for waste storage is planned by non-microbiologists?

- A:** The space will be located too far from the main laboratory
- B:** The space will likely be insufficient for weekends and holiday weekends
- C:** The waste streams for different materials will not be properly segregated
- D:** The area will lack proper ventilation and drainage

Question 8: What type of teaching experience can be accommodated at existing work benches without requiring a separate classroom?

- A:** The delivery of didactic lectures for medical technology students
- B:** Performing wet laboratory exercises
- C:** "Shadowing" of experienced technologists by newly hired technologists or residents
- D:** Remote transmission of high-resolution microscopic images

General Considerations

Question 9: What is the minimum recommended linear feet of bench top per designated workstation?

- A:** 3 linear feet
- B:** 6 linear feet
- C:** 8 linear feet
- D:** 10 linear feet

Question 10: Why is it recommended to place electrical outlets on both the left and right sides of a bench?

- A:** To meet national electrical code standards
- B:** To provide power for both 110V and 220V equipment
- C:** To avoid long electrical cords or use of extension cords spanning across the work bench
- D:** To allow for easy connection of floor-standing instruments

Question 11: What is the recommended timing for installing electrical outlets and IT ports?

- A:** After construction is complete
- B:** During the planning phase
- C:** At the time of construction
- D:** After equipment installation

Question 12: What should be included near laboratory exits?

- A:** Storage cabinets
- B:** Hand-washing sinks
- C:** Computer stations
- D:** Waste bins

Question 13: What is recommended regarding floor drains in the laboratory?

- A:** Only place them near sinks
- B:** Avoid them completely
- C:** Only in waste areas
- D:** Place them throughout the laboratory

Question 14: What requires emergency electrical backup power in the laboratory?

- A:** All electrical equipment
- B:** Only computers
- C:** Equipment required for patient care and employee safety
- D:** Only refrigeration units

Question 15: Where should office space for directors and supervisors be located?

- A:** In a separate building
- B:** On a different floor
- C:** Immediately adjacent to the laboratory
- D:** In a central administration area

THE END



FOCUS ON HEALTH

www.foh-cpd.co.za

Cell: 074 230 3874

Tel: 012 653 0133 / 2373 / 2394

Mon-Fri: 08:00-16:00

400 Theuns van Niekerk Street

Wierda Park

0157

PO Box 71

Wierda Park

0149

MEMBER INFO

(Complete sections marked with an asterisk *)

*FOH number

*HPCSA number

ID number

Personal detail changes

I hereby declare that the completion of this document is my own effort without any assistance.

SIGNED:

DATE:

This activity is accredited for **SIX (6) CLINICAL** CEU'S. You have to achieve 70% to pass this activity.

ANSWER SHEET

L6(26)

Practical Aspects and Considerations When Planning a New Clinical Microbiology Laboratory

*Time spent on activity											hour	min											
PART 1											PART 2												
	A	B	C	D	E		A	B	C	D	E		A	B	C	D	E		A	B	C	D	E
1						8						1						8					
2						9						2						9					
3						10						3						10					
4						11						4						11					
5						12						5						12					
6						13						6						13					
7						14						7						14					
						15												15					

How relevant was the content of this activity to your scope of practice?			
			
Not at all	Somewhat	Mostly	Extremely

RETURN ANSWER SHEET TO

Online members, complete your answer sheet online

CPD PORTAL: <http://foh-cpd.co.za/cpd-online/cpd-user> (Username: FOH number & Password: ID)

(Results are available immediately)

Email or hard copy members, complete your answer sheet online or return it to:

WHATSAPP: 074 230 3874 EMAIL: info@foh-cpd.co.za

(Results will be sent via email)

You will receive a confirmation of receipt SMS within 12-24hours, if not received please send again.

Have a suggestion or comment?

Send it to us on EMAIL or WHATSAPP