How Well Are We Training the Next Generation of Clinical Pathologists and Clinical Laboratory Directors?  
A Global Perspective

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Like most areas of medicine, the clinical laboratory [clinical pathology (CP)] is seeing a rapid introduction of new technologies and science. New biomarkers for diagnosis, prognosis, prediction of response to therapy, and future risk are being proposed at such a high rate that it is difficult to keep up with the literature. At the same time, the aging population of the developed world will demand more laboratory medicine services. Finally, laboratory directors (both MD and PhD) are themselves an aging population, with some estimates suggesting that up to 50% of current laboratory directors in the US will retire in the next 10 years. Considering all of these factors, many questions have been raised about training the next generation of clinical laboratory directors and clinical (or chemical) pathologists with respect to how many to train, what areas of our field need to be emphasized, and whether research is an important aspect of training. Here, 5 leaders from around the globe who are deeply involved with training the next generation of laboratory medicine scientists and physicians answer some of the questions that are being faced by all of us who are actively engaged in training.

Considering the demographics of aging in our field, do you believe we are training too few, too many, or about the right number of future clinical laboratory directors? Are your trainees finding jobs quickly after completing training?

Brian Smith: In my opinion we are training too few clinical laboratory pathologists and directors in the US who provide appropriate and needed medical consultative services to clinicians. The explosion in diagnostic testing has resulted in a world where primary care physicians and many specialists can no longer maintain a sufficient knowledge base to optimally apply the results of complex laboratory studies to the diagnosis and care of their patients. In addition to interpreting the results of testing, there is also a gap in understanding the fastest and most cost-effective approaches to testing for a particular patient. This growing problem is recognized by the CDC and other national organizations. While it may be possible to employ electronic approaches to help abrogate this growing “clinical care gap” (e.g., consultative algorithms available as part of an electronic medical record ordering system), such solutions will always be aids to nonlaboratory clinicians rather than full answers. Our laboratory medicine trainees are finding jobs quickly. Interestingly, we have also recently received inquiries from individuals trained only in anatomic pathology to see if they could receive 12 additional months of rigorous CP training, since they believe that, increasingly, available jobs will require American Board of Pathology-certified CP skills.

Alan Wu: Right now, the number of PhD trainees in clinical chemistry programs across the US is about right, but this is about to change, as many current clinical laboratory directors are nearing retirement age. Our trainees are not having difficulty finding positions; most have
several choices and start right after their training ends.

**Ian Young:** Overall, it seems likely that we are currently training too many clinical scientists and medically qualified clinical chemists for future vacancies in the UK. However, a lack of comprehensive, accurate information about the number of trainees in the system and the retirement plans of senior staff means that there is a considerable degree of uncertainty in such estimates. Certainly, at present, some trainees struggle to find suitable jobs quickly after the completion of training. This situation is exacerbated by a significant trend toward consolidation of clinical laboratory services and by the operation of recruitment freezes in many healthcare organizations as part of an overall strategy to deal with cutbacks in government funding.

**Mario Plebani:** The optimal number of future laboratory directors in Italy and other European nations is difficult to determine, as different drivers affect it. On one hand, recent changes in pension regulation, continued uncertainty regarding national service, and the ongoing process of consolidation and centralization of clinical laboratories make the number of future positions needed unpredictable. On the other hand, the expected increased demands for molecular testing and innovative technologies, along with the aging population in Europe that will need increased healthcare, suggest the need for additional laboratory services and hopefully personnel. Nevertheless, current trainees find jobs very quickly after completing their program. However, this is due, at least partially, to the few training positions in many universities and, unfortunately, to the decreased number of physicians who are interested in training in laboratory medicine.

**Ross Chiu:** In Hong Kong, pathology training is discipline specific. My comments relate to chemical pathology training only. For chemical pathology, the number of trainees is insufficient to fulfill the service demand in Hong Kong. Trainees are finding jobs quickly after completing training. There are increasing job opportunities in chemical pathology due to a number of factors. First, a large proportion of the current chemical pathologists are reaching retirement age. Second, laboratory accreditation has resulted in many laboratories wanting to improve their service by hiring chemical pathologists. Third, there is a need for subspecialization in certain areas of chemical pathology, e.g., the development of tertiary toxicology service and genetic testing in Hong Kong. Despite these factors, the present number of trainees is limited by the current training capacity, because training can be offered only at centers staffed with a chemical pathologist. Thus, there is a mismatch between supply and demand.

**How important is it for research to be a component of training? What percentage or length of training do you think should be devoted to research? Do you have a preference for the type of research (e.g., basic, translational, clinical) that should be performed by fellows and/or residents?**

**Alan Wu:** Research is a major differentiator between individuals who are otherwise equally qualified, especially for positions at academic medical centers. This is particularly relevant when a clinical laboratory scientist (PhD) is competing against a pathologist (MD) for the same position. The pathologist has the advantage of being broadly trained. Moreover, there continues to be an “MD” bias in some pathology and laboratory medicine departments. Therefore, the doctoral scientist must have additional qualifications, e.g., research, that enables him/her to stand out. In my opinion, translational and/or clinical research is the most relevant for trainees interested in becoming a laboratory director. To produce a competitive resume, I believe that at least 50% of time must be devoted to research during the training program. Residents in pathology will not be able to match this effort during their 2 years of CP rotations unless they are graduates of a medical scientist training program (MSTP) and have both the MD and PhD degrees.
Mario Plebani: Fellows and residents must include research, particularly translational research, as a main component of their training. I believe that at least 30% of the entire training should be devoted to research and include studies devoted both to evaluation of new techniques/methods and to correctly understand and interpret results. Both basic and clinical research is important, but for appropriate professional development, translational research and the introduction of innovative methods and tests into clinical practice are more important. In particular, research is a major discriminator between individuals competing for positions at academic medical centers.

Rossa Chiu: My view is that research is an important component for training in chemical pathology, because new methods, tests, and markers are constantly being developed and implemented. Skills acquired through research that I believe are beneficial to building a career in chemical pathology include: knowledge about robust study/experimental designs, ability to interpret data objectively and critically, and development of a desire for innovation. The most relevant type of research that I recommend would be translational research. One-third of the training period devoted to research would be appropriate.

Brian Smith: The nature of quality clinical laboratories includes assay development and validation. Hence, the practice of laboratory medicine intrinsically involves some “research and development.” Moreover, the evaluation of new technologies and tests is best supported by some background in the cognitive and procedural aspects of research. Training should include research, but the nature of that research (basic, translational, clinical) should be optimized for the planned career path of the trainee. Six months of research is generally appropriate for the house officer planning a predominantly clinical career. Those planning a career that includes ongoing investigation require more training. Ideally, there would be an officially sanctioned “physician–scientist” track in pathology analogous to the tracks that are promulgated in medicine and pediatrics by their respective boards and residency review committees.

Ian Young: Research is seen as an important component of training in the UK, and it remains a mandatory requirement for all trainees to complete a research project and write a dissertation. This is usually completed part time over 1 year. Many trainees in addition will have completed a higher research degree (PhD or equivalent) before entering the profession, or will take time out during their training to do so. A wide variety of research types, including basic, translational, and clinical, are considered acceptable. However, my personal preference would be for translational or clinical projects. In routine clinical practice, this is the area where the greatest contribution is likely to be made. While research training is important, the ability of clinical chemists to carry out research once fully trained is under pressure. As laboratories come under increasing financial pressure, research is often seen as a luxury unless full external funding to cover the costs can be obtained. There is a trend for research capacity to become concentrated in a reduced number of centers with a strong academic profile, rather than being part of every laboratory.

Technologies and new biomarkers represent areas of rapid expansion in our field. Are you aware of weaknesses in our current training programs in relation to these emerging areas or in any other areas?

Brian Smith: Training programs vary in their devotion to training in genomic and proteomic bioinformatics, and this is an area that should be included for the upcoming generations of trainees. Training in the design and interpretation of multiparameter assays is another area that will require more attention in future years.

Alan Wu: Molecular diagnostics is the specialty that is expanding the fastest. It is important for trainees to have experience in molecular testing, particularly for inherited diseases, cancer, infectious diseases, pharmacogenomics, and forensics. Emerging technologies include single-nucleotide polymorphism detection, expression arrays, fluorescence in situ hybridization, and next-generation sequencing. The training in molecular diagnostics is not consistent among clinical chemistry programs in the US due to issues such as access to available technologies and qualified instructors, and competition for training from other programs. Mass spectrometry is another technology that postdoctoral fellows should have experience with. This is essential for any toxicology position. Individuals conducting research into the discovery of novel biomarkers will also require mass spectrometry experience. As with molecular diagnostics, the access of fellows to mass spectrometry is highly variable between clinical chemistry training programs in the US. Point-of-care diagnostics represents another emerging area of interest among clinical chemists. Novel microfluidics and signal-detection technologies offer clinical research opportunities for fellows.

Ian Young: In general, current training programs in the UK provide good exposure to and training in technologies that are beginning to establish themselves in routine practice. However, exposure to emerging tech-
niques in proteomics, metabolomics, or similar areas is more limited. It seems likely that such approaches will form part of routine practice in the future, and I think there is room for improved training in these areas. With respect to new biomarkers, training is good where these have entered routine practice but more limited in the case of emerging biomarkers. I think that all trainees should be taught to have a broad awareness of emerging biomarkers, but given the fact that many such biomarkers fail to make it to routine clinical practice in the UK, it is difficult to know how much emphasis to place on individual biomarkers in the research stage.

Mario Plebani: Laboratory medicine is a heterogeneous discipline requiring many different skills. The diversity and complexity of modern laboratory testing precludes the acquisition of in-depth knowledge of all analytical methods, technologies, and biomarkers, and some training centers are stronger in certain areas than in others. In particular, the validation of research biomarkers requires knowledge of pre-, intra-, and post-analytical variables that strongly affect their interpretation and clinical usefulness. Clinical consultation represents another area of weakness in training programs. A body of evidence demonstrates the importance of residents participating in cross-training, in team rounds with other clinical residents, and in interdisciplinary studies. It would be useful to involve residents in 2- or 3-week rotations in the clinical wards to provide them with a better idea on how clinicians use laboratory tests so they can help them improve the practice of test request, result interpretation, and test utilization. Finally, it would be important to prepare residents for the new era in laboratory diagnostics, which will include the new generation of molecular and genomic techniques; clearly not all training programs are equally proficient in these areas.

Rossa Chiu: In Hong Kong, our trainees’ exposure is very much dependent on what technological platforms and expertise are available at the training center that the trainee is affiliated with. Rotations between training centers would broaden the trainees’ exposure. However, due to the tight staffing levels in most centers, it is difficult to offer protected time for training, e.g., for the purpose of training rotations.

Brian Smith: Pathology has not yet fully embraced the generalist–specialist models so common in medicine, pediatrics, and surgery. Core broad training in anatomic pathology and/or CP is necessary for all, but it should be possible to begin to move to a system that recognizes new training paradigms for those who ultimately wish to specialize. For example, combined CP/transfusion medicine training may not require a full 4 clinical years for clinical expertise if the trainee intends to devote their career solely to transfusion. One of the potential uses for modified subspecialty training would be for those planning a physician–scientist career path, analogous to the common model in internal medicine of physician–scientist “short tracking” for subspecialists.

Rossa Chiu: I think trainees should be broadly trained initially and develop some level of specialization subsequently. The degree of specialization to pursue would depend on the job opportunities available. Too high a degree of specialization may limit the number of positions that may suit the profile of individual trainees.

Brian Smith: Pathology has not yet fully embraced the generalist–specialist models so common in medicine, pediatrics, and surgery. Core broad training in anatomic pathology and/or CP is necessary for all, but it should be possible to begin to move to a system that recognizes new training paradigms for those who ultimately wish to specialize. For example, combined CP/transfusion medicine training may not require a full 4 clinical years for clinical expertise if the trainee intends to devote their career solely to transfusion. One of the potential uses for modified subspecialty training would be for those planning a physician–scientist career path, analogous to the common model in internal medicine of physician–scientist “short tracking” for subspecialists.

Mario Plebani: The delivery of laboratory services in Italy is increasingly organized as a department of laboratory medicine covering all fields of the discipline, from clinical chemistry to hematology/coagulation, microbiology, and molecular pathology. Therefore, residents should be broadly trained to understand and manage the knowledge of this heterogeneous discipline. At the end of the training, including the thesis preparation and discussion, each resident should discuss with his/her mentor the specific subspecialty or area of research for more specialized training.

In your view, is it important that our trainees be broadly trained, or should they specialize from the beginning of training?

Ian Young: I think that a broad initial training is essential, with specialization taking place in the later years of the training process. This has been the traditional model in the UK and has served us well.

Alan Wu: Broad-based training is important for most individuals who have no or minimal prior experience in clinical laboratory science. Those who are former medical technologists will have an advantage at first. This initial experience will enable them to select a specialty based on their interests, qualifications, and access to clinical collaborations. To be most productive, an individual needs to select an area of interest as soon as realistically possible, with the recognition that the trainee does not need to spend his/her entire time within that selected specialty. It is essential for faculty members of the training program to be mentors and role models for fellows to guide them along this process.
**Finally, what certifications (boards) do your graduates need to serve as a laboratory director?**

**Rossa Chiu:** In Hong Kong, directors of laboratories performing complex tests are required to be a Fellow of the Hong Kong Academy of Medicine, a distinction that is granted upon attaining the status of Fellow of the Hong Kong College of Pathologists.

**Alan Wu:** In California, laboratory directors must possess a license from the state, initially as a laboratory specialist, and later as a laboratory director. Individuals must be graduates from programs that are approved by the state. There are proposals to the California Code of Regulations to permit graduates of Commission on Accreditation in Clinical Chemistry–accredited programs to qualify for licensure. In the US, boards such as the American Board of Clinical Chemistry are required of nonphysician laboratory directors.

**Brian Smith:** Our MD graduates generally become laboratory directors in the community with just American Board of Pathology clinical pathology boards. Nevertheless, we see a definite trend toward community practices looking for trainees with separate transfusion medicine boards if there is no one else in the practice so trained. There is also a trend for practices to want at least one partner with hematology (pathology) boards. Although we encourage MD trainees who will direct chemistry and/or molecular laboratories to obtain subspecialty boards in chemical pathology and/or molecular genetic pathology, we have not seen someone fail to obtain such a job because of lack of the subspecialty board. Similarly, although there is an edge for those with medical microbiology boards from the American Board of Pathology or microbiology certification from the American Society of Microbiology to become microbiology directors, we have trainees take such positions without formal subspecialty certification.

**Ian Young:** To serve as a laboratory director in the UK requires one to be a Fellow of the Royal College of Pathologists, a distinction that is awarded by examination after a number of years of appropriate training. In addition, medically qualified laboratory directors need to be on the relevant specialist register, and clinical scientists must be registered with the Health Professions Council.

**Mario Plebani:** In Italy, the school of medicine of each university has the role of certifying the graduates. However, I believe that a professional body, such as the Royal College of Pathologists in the UK, is much more appropriate to certify competence of the trainees, perhaps in cooperation with the university.

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