Worldwide standardized education and training in clinical chemistry and laboratory medicine

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IFCC-General Conference Madrid/Spain
19-21 March 2016
Purpose

• Competency-based education for training laboratory medicine specialists

• Roles
  – IFCC
  – National Societies
Content

- Competency-based education
- Steps for competency-based education
- Some terms and their meanings
  - Milestones
  - Entrustable professional practices (EPAs)
- Implementations
- Competency-based education framework in laboratory medicine
- Roles of the National Societies and the IFCC
Laboratory Medicine

The branch of medicine in which specimens of tissue, fluid, or other body substance are examined outside of the person, usually in the laboratory or near patient sites
Some fields of LM (EU Directive 2013/55/EU for specialists in laboratory medicine, EC4)

- Clinical Chemistry/Immunology,
- Haematology/Blood Transfusion,
- Microbiology/Virology,
- Genetics
- *in vitro* fertilization
Some fields of LM (ACGME Accreditation in US) (2013)

- CP-oriented subspecialties such as
  - blood banking / transfusion
  - chemical pathology
  - hematology
  - medical microbiology
  - medical toxicology
  - medical biochemical genetics
  - molecular genetic pathology

(Genzen JR, eJFCC, 2013, eJIFCC2013Vol24No1pp030-036)
Competency-based education

Education models

- Time-based
- Process-based
- Workplace-based
- Competency-based/Outcome-based
Competency-Based Education

..is an approach to preparing residencies for practice that is fundamentally oriented to graduate outcome abilities and organized around competencies derived from an analysis of societal and patient needs.

CBE focuses on outcomes of learning

Frank et al, 2010
Steps in planning CBE curricula

1. Identify the abilities needed of graduates
2. Explicitly define the required competencies and their components
3. Define milestones along a development path for the competencies
4. Select educational activities, experiences, and instructional methods
5. Select assessment tools to measure progress along the milestones
6. Design an outcomes evaluation of the program.
A Model of CBE

External Standards

Education Standards

Curriculum

Assesments

Instructional Materials/Format

Professional Development

Implement and Feedback

Frank J. Med Teach, p.638. 2010
A Model of CBE

What the graduates perform as a proficient laboratory medicine specialists

External Standards

Educational Standards

Curriculum

Instruction Materials

Professional Development

Implement and Feedback

Assesments
Laboratory responsibility at individual level

Adapted from Plebani, 2011
At population level

Population → Physicians → Healthcare providers → Pre-pre-analytical

Pre-pre-analytical → Pre-analytical → Analytical → Medical Laboratory

Adapted from Plebani, 2011
ISO 15189: Medical laboratories — Particular requirements for quality and competence
Deming Quality Circle (PDCA)

Plan

Do

Act

Control

Total Quality Management
TQM Model (Westgard)

Lean Management
Six Sigma

Risk Assessment

ISO/CLSI documents

Internal audit and accreditation

Root-cause Analysis
Six Sigma
DMAIC

Quality measures and indicators

Repeatability
Reproducibility
Trueness
Imprecision

SD
CV
Bias

IFCC – GC, 19-21 March 2016
Evidence-based (laboratory) medicine processes

Clinical or Policy Problems

Ask

Assess

Apply

6A

Acquire

Appraise

Plan

Do

Act

Control

IFCC – GC, 19-21 March 2016
Evidence-based (laboratory) medicine processes in practice

Clinical or Policy Problems

Identify question

Audit practice

Modify process

Apply to practice

Search the evidence

Critically appraise evidence

Plan → Do → Control

IFCC – GC, 19-21 March 2016
Health outcome in hierarchy of evidence

Use of biomarkers improve health outcomes?

- Clinical validity
  - Effectiveness

Analytic validity
- Biologic variation
- Clinical utility
- Efficacy

- Diagnostic performance
- Technical performance

- Diagnostic impact
- Therapeutic impact
- Clinical impact
- Organizational impact
- Cost-effectiveness
- Decision

Routine practice and performances
- Pre-analytical
- Analytical
  - Internal quality control
  - External quality assessment
- Post-analytical

IFCC – GC, 19-21 March 2016
The clinical decision-making loop

(Collinson PO. Edts. Price CP, Christenson, RH. EBLM Principles, Practice, and Outcomes 2nd Edt. 2007)
Lifecycle of IVD
A Model of CBE

Define competencies and their components

External Standards

Educational Standards

Curriculum

Assesments

Instructional Materials/Format

Professional Development

Implement and Feedback

Frank J. Med Teach, p.638. 2010
Competency

An observable ability of a health professional integrating multiple components such as knowledge, skills, values, and attitudes.

Frank et al, 2010
The ACGME/ABMS framework identifies six domains of competence:

- Patient Care (PC),
- Medical Knowledge (MK),
- Interpersonal and Communication Skills (ICS),
- Professionalism (P),
- Practice-Based Learning and Improvement (PBLI)
- Systems-Based Practice (SBP).

Each domain includes a set of competencies.
Competency Domains (Canada)

Royal College of Physicians and Surgeons of Canada (RCPSC) adopted an outcome-based framework of competencies called CanMEDS

- Medical expert
- Communicator
- Collaborator
- Manager
- Health advocate
- Scholar
- Professional

http://www.royalcollege.ca

Zeller M. 2015
## Competency Roles in CBME (Canada)

<table>
<thead>
<tr>
<th>Role</th>
<th>134 elements</th>
<th>28 key competencies</th>
<th>125 enabling competencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical expert</td>
<td>14</td>
<td>6</td>
<td>27</td>
</tr>
<tr>
<td>Communicator</td>
<td>27</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>Collaborator</td>
<td>21</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>Manager</td>
<td>21</td>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td>Health advocate</td>
<td>11</td>
<td>3</td>
<td>14</td>
</tr>
<tr>
<td>Scholar</td>
<td>23</td>
<td>4</td>
<td>25</td>
</tr>
<tr>
<td>Professional</td>
<td>17</td>
<td>3</td>
<td>14</td>
</tr>
</tbody>
</table>

http://www.royalcollege.ca

Ten Cate, 2013
Competency Domains by different organizations

<table>
<thead>
<tr>
<th>Institution</th>
<th>Deans of Scottish Medical Schools</th>
<th>U.S. Accreditation Council for Graduate Medical Education</th>
<th>Indiana University School of Medicine</th>
<th>University of New South Wales Medical School</th>
</tr>
</thead>
</table>

Roles CanMEDs

- Professional
- Medical expert
- Communicator
- Health advocate
- Manager
- Scholar

Gruppen LD, 2014
Consensus Guidelines for Practical Competencies in Anatomic Pathology and Laboratory Medicine for the Undifferentiated Graduating Medical Student

Margret S. Magid, MD¹, Darshana T. Shah, PhD², Carolyn L. Cambor, MD³, Richard M. Conran, MD, PhD, JD⁴, Amy Y. Lin, MD⁵, Ellinor I.B. Peerschke, PhD⁶,⁷, Melissa S. Pessin, MD, PhD⁸, and Ilene B. Harris, PhD⁹
UNIT 1 Collection, preparation and analysis of clinical material

Element

1.1 Ensure the appropriateness of sample collection procedures
1.2 Ensure the appropriateness of specimen reception procedures
1.3 Evaluate specimen suitability prior to analysis
1.4 Determine the priority of laboratory requests (triage) to effectively manage service requirements
1.5 Process specimen utilising appropriate techniques
1.6 Read and validate results Equipment
Competency Guidelines for Public Health Laboratory Professionals

CDC and the Association of Public Health Laboratories
Competency Guidelines for Public Health Laboratory Professionals

15 competency domains
122 competencies
519 subcompetencies
Competency domains for laboratory medicine specialists (15)

1. Quality Management System
2. Ethics
3. Management and Leadership
4. Communication
5. Security
7. Workforce Training
8. General Laboratory Practice
9. Safety
10. Surveillance
11. Informatics
12. Microbiology
13. Chemistry
14. Bioinformatics
15. Research
Schematic of competency domains for public health laboratory professionals

- Quality Management System
- General Laboratory Practice, Safety, Surveillance, Informatics
- Microbiology, Chemistry, Bioinformatics, Research
- Specialized
- Cross-cutting
- General
Competency Guidelines for Public Health Laboratory Professionals

Competencies and Skill Domains

Quality Management System Competency Guidelines

Ethics Competency Guidelines

Management and Leadership

Communication Competency Guidelines

Security Competency Guidelines

Emergency Management

Workforce Training Competency Guidelines

General Laboratory Practice

Safety Competency Guidelines

Surveillance Competency Guidelines

Informatics Competency Guidelines

Microbiology Competency Guidelines

Chemistry Competency Guidelines

Bioinformatics Competency Guidelines

Research Competency Guidelines
## TABLE 1. Public health laboratory competency guidelines: Quality Management System (QMS) domain

<table>
<thead>
<tr>
<th>Subcompetency</th>
<th>Beginner</th>
<th>Competent</th>
<th>Proficient</th>
<th>Expert</th>
</tr>
</thead>
<tbody>
<tr>
<td>QMS 1.01. Commitment to quality</td>
<td>Describes quality concepts and good professional practice</td>
<td>Demonstrates actions consistent with quality concepts and good professional practice</td>
<td>Sustains laboratory quality management system (QMS)* processes and procedures to ensure good professional practice</td>
<td>Oversees the development of policies,* processes,* and procedures* for review and maintenance of the QMS</td>
</tr>
<tr>
<td>QMS 1.02. Organizational structure</td>
<td>Identifies the laboratory’s organizational structure that ensures quality</td>
<td>Explains how the laboratory’s organizational structure ensures quality</td>
<td>Manages organizational structure to ensure quality</td>
<td>Coordinates organizational structure to ensure the QMS is well-integrated into all levels of laboratory operations</td>
</tr>
</tbody>
</table>
A Model of CBE

Define competency Components?
Knowledge, skills and attitudes

External Standards

Educational Standards

Curriculum

Instructional Materials/Format

Professional Development

Implement and Feedback

Assesments

Frank J. Med Teach, p.638. 2010
Competency components

**Competency:** An observable ability of a health professional, integrating multiple components such as

- knowledge
- skills
- values
- attitudes
Laboratory Medicine (AU)

- Laboratory Medicine Scientist (Bachelor of Science) (http://www.murdoch.edu.au/Courses/Laboratory-Medicine/)
- PhD in Medical Laboratory Sciences (http://www.healthcarestudies.com/PhD-in-Medical-Laboratory-Science/Australia/RMIT-University/)
- Basic Pathological Sciences (Royal College of Pathologists)
- Chemical Pathologists and Scientists (http://www.aacb.asn.au)
Training in Laboratory Management and the MBA/MD in Laboratory Medicine

Box 2. Laboratory management curriculum in laboratory medicine training

Trainees should learn to develop the following skills and competencies:

Organizational and leadership skills

Skill level I
- The fundamentals of human behavior in organizations (e.g., management structure and function, the structure of differing practice settings)
- Interpersonal skills to effectively manage, lead, and motivate others
- The role of ethics in medical and managerial decision making
- The different responsibilities of pathologists, administrators, and technologists
- The relationships between pathologists, hospitals, and medical staff (e.g., contracts, decision making, negotiation)
- The environment of patient-oriented and ethical service

Skill level II
- Understand human resource systems (e.g., recruitment, retention, performance measurement)

Financial skills

Skill level I
- The fundamentals of financial data collection and financial statement analysis
- The budgeting process for operational planning, management, and control
- How to properly assign current procedural terminology (CPT) codes

Skill level II
- Assess the need for new laboratory instrumentation (e.g., budget justification)
- The nature and behavior of costs in the laboratory (e.g.,跟踪, accounting)
- The applicable forms of reimbursement for pathologists working in clinical laboratories (e.g., Medicare, managed care, health insurance)
- How to monitor, effectively influence, and manage laboratory performance in a healthcare organization

Regulatory skills

Skill level I
- The accrediting agencies relevant to laboratory certification and licensure
- Participate in at least one CAP self-inspection event
- The “test complexity” model of Clinical Laboratory Improvement Amendments (CLIA) (i.e., high complexity, moderate complexity, waived, physician-performed microscopy)
- Understand the compliance requirements for laboratories (e.g., CLIA, the model compliance plan of the Office of the Inspector General)
- Understand the patient privacy and electronic data security

Skill level II
- The principles involved in the determination of test reference intervals
- How to choose, use, and monitor the performance of reference laboratories

Current curriculum in laboratory management at the University of Utah

Box 3. Current curriculum in laboratory management at the University of Utah
Introduction to management principles
Human resources management
Financial management
Operations management
Quality, regulatory compliance, and risk management
Pathology practice characteristics and contracting
Political advocacy
Strategic planning
Business development
Marketing, advertising, and promotion
Outreach development
Sales management

Smith R, 2006; Weiss R. 2007
Box 4. Current curriculum in medical informatics at the University of Utah
Overview and introduction to medical informatics
Excel spreadsheets
Statistical analysis
Sensitivity and specificity
Likelihood ratios
Assay comparison, linear regression, and nonlinearity
Reference intervals
Data-mining
Improving test ordering and interpretation
Cost-effectiveness analysis
Bioinformatics in clinical research Information technology security
Laboratory information systems
Laboratory information technology management
Image analysis
Public health reporting
Use of the internet (eg, PubMed, e-mail, social issues)
Hospital information systems and the electronic medical record

Smith R, 2006; Weiss R. 2007
EC4 Syllabus for Laboratory Medicine

Core knowledge, skills and competencies

I. Basic knowledge requirements
II. Indications for laboratory medicine procedures
III. Influence of collection and storage of specimens
IV. Analytical principles and techniques
V. Analytical evaluation of laboratory methods
VI. Clinical evaluation of laboratory methods
VII. Case-related medical evaluation of laboratory tests
VIII. Clinical training
IX. Research and development; audit
X. Laboratory management and quality assurance
Medical Biochemistry specialist training syllabus (Our Department)

Laboratory safety
General laboratory principles and techniques
Information technology
  Laboratory Information System (LIS)
  Hospital Information System (HIS)
Biochemistry in health and disease
Method development, validation and verification
Quality Management
  Internal quality control
  External quality assessment
  Proficiency schemes
Medical Biochemistry specialist training syllabus (Our Department)

Clinical laboratory management
   Pre-analitical processes
   Analitical processes
   Post-analytical processes
   Standard operation procedures
   Risk management

Skills
   Decision for analytical techniques
   Decision for entruments
   Data manageent
   Interpretation
   Outcome analysis
   Managerial skills
Medical Biochemistry Specialist Training Syllabus (Our Department)

- Communication skills
- Role in the hospital management
- Procurement
- Standardization, certification, accreditation
- Good clinical laboratory practices
- Evidence-based of laboratory medicine
- Teaching skills
- Organization of Meetings
- Research and development skills
- Lifelong learning
A Model of CBE

Define milestones along a development path for the competencies

External Standards
Educational Standards
Curriculum
Assesments
Instructional Materials/Format
Professional Development
Implement and Feedback

Frank J. Med Teach, p.638. 2010
Milestones

A milestone is a behavioral descriptor that marks a level of performance for given competency.

- The levels of milestones are defined based on the Miller’s Pyramid.

(derived from the ACGME Milestones Project)
Assessment in Competency-Based Education

Miller’s pyramid

Behavior in the workplace

Behavior in simulation exams

Applied knowledge

Factual knowledge

Miller G. 1990
Level 1: The fellow demonstrates milestones expected of an incoming fellow.

Level 2: The fellow is advancing and demonstrates additional milestones, but is not yet performing at a mid-fellowship level.

Level 3: The fellow continues to advance and demonstrates additional milestones, consistently including the majority of milestones targeted for fellowship.

Level 4: The fellow has advanced so that they now substantially demonstrate the milestones targeted for fellowship. This level is designed as the graduation target.

Level 5: The fellow has advanced beyond performance targets set for fellowship and is demonstrating “aspirational” goals which might describe the performance of someone who has been in practice for several years. It is expected that only a few exceptional fellows will reach this level.

Novice: Don’t know what they don’t know

Advanced beginner: Know what they don’t know

Competent: Able to perform the tasks and roles of the discipline – restricted breath and depth

Proficient: know what they know and don’t know

Expert: know what they know

https://www.acgme.org
Pathology and Laboratory Medicine (USA) (2016)

http://www.acgme.org/acgmeweb/tabid/142/ProgramandInstitutionalAccreditation/Hospital-BasedSpecialties/Pathology.aspx (2016)
The Chemical Pathology Milestone Project

A Joint Initiative of

The Accreditation Council for Graduate Medical Education

and

The American Board of Pathology
# Milestones Levels

## Chemical Pathology Milestones Project

![Diagram](https://www.acgme.org)

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### Level 1
- Understands the role of the consultant in chemical pathology
- Observes and assists in the consultation
- Able to use the EMR and other electronic resources to obtain clinical and disease information

### Level 2
- Performs clinically useful consultation in a timely manner
- Prepares full and complete consultative reports with faculty guidance

### Level 3
- Effectively communicates consultative recommendations and action plans
- Develops a portfolio of consultations
- Independently prepares full and complete consultative reports

### Level 4
- Effectively teaches consultation skills
- Competently and independently performs consultation during regular working hours and while on call

### Level 5
- Proficient in chemical pathology consultations (including those involved in complex clinical scenarios)
- Proficient in consultation regarding complicated patient evaluations
- Demonstrates expertise at the level expected of a subspecialist in chemical pathology

---

Selecting a response box in the middle of a level implies that milestones in that level and in lower levels have been substantially demonstrated.

Selecting a response box on the line in between levels indicates that milestones in lower levels have been substantially demonstrated as well as some milestones in the higher level(s).

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https://www.acgme.org

IFCC – GC, 19-21 March 2016
Milestones

The CBD^1^2 Competence Continuum

By introducing a competency-based medical education model to resident training and specialty practice, the CBD initiative will break down specialist education into a series of integrated stages — starting at transition to discipline and moving through practice. The CBD Competence Continuum provides a quick look at the new stages which begin upon entry into a discipline-specific residency following the attainment of the MD designation.

In this last stage, physicians adapt to the final practice period and their changing healthcare role.

As part of enhanced expertise, the physician’s scope of practice evolves over time to respond to practice needs, interests and acquisition of skills and abilities.

This stage covers the core competencies that make up the majority of a discipline. This stage corresponds to the Senior Resident status currently used within the existing education model.

This “new” stage emphasizes the orientation and assessment of new trainees arriving from different medical schools and programs (including outside Canada). This stage may be one hour, one day, one month or two months, depending on program needs. This stage corresponds to the Junior Resident status currently used within the existing education model.

As part of maintenance of competence, a physician progresses in competence to attain expertise through CPD within their scope of practice. Throughout this stage the physician is focused on learning in practice.

In this stage, the senior trainee should demonstrate readiness to make the transition to autonomous practice. Within CBD, examination would take place at the end of the “core of discipline” stage, allowing residents to hone their competencies in their last months of training. Royal College certification will be granted upon the successful completion of the Transition to practice stage. This last stage of residency continues to correspond with the Senior Resident role in the existing model.

This stage covers broad-based competencies that every trainee must acquire before moving on to more advanced, discipline-specific competencies. This stage continues to correspond with Junior Resident status.

http://www.royalcollege.ca
A Model of CBE

Select educational activities, and instructional methods

External Standards

Educational Standards

Curriculum

Assesments

Instructional Materials/Format

Professional Development

Implement and Feedback

Frank J. Med Teach, p.638. 2010
Select assessment tools to measure progress along the milestones.

External Standards

Educational Standards

Curriculum

Assesments

Instructional Materials/Format

Professional Development

Implement and Feedback
Decisions for level of supervision

Entrustable Professional Activities (EPAs)

The entrustable professional activity (EPA) concept allows faculty to make competency-based decisions on the level of supervision required by trainees.
Entrustable Professional Activities (EPAs)

«Core unit of professional work that can be identified as a task to be entrusted to a trainee once sufficient competence has been reached»

- EPAs are not an alternative for competencies, but a means to translate competencies into clinical practice
- Competencies are descriptors of specialists
- EPAs are descriptors of work

ten Cate, 2005; ten Cate 2013  Dhaliwal U. 2015; Jonker G. 2014,
## Entrustable Professional Activities (EPAs)

**TABLE 2**  
**GUIDELINES FOR FULL ENTRUSTABLE PROFESSIONAL ACTIVITIES DESCRIPTIONS**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Title</strong></td>
<td>Make it short; avoid words related to proficiency or skill. Ask yourself: Can a trainee be scheduled to do this? Can an entrustment decision for unsupervised practice for this EPA be made and documented?</td>
</tr>
<tr>
<td><strong>2. Description</strong></td>
<td>To enhance universal clarity, include everything necessary to specify the following: What is included? What limitations apply? Limit the description to the actual activity. Avoid justifications of why the EPA</td>
</tr>
<tr>
<td><strong>3. Required Knowledge, Skills, and Attitudes (KSAs)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>4. Required KSAs</strong></td>
<td></td>
</tr>
<tr>
<td><strong>5. Information to assess progress</strong></td>
<td></td>
</tr>
<tr>
<td><strong>6. When is unsupervised practice expected?</strong></td>
<td></td>
</tr>
<tr>
<td><strong>7. Basis for formal entrustment decisions</strong></td>
<td></td>
</tr>
</tbody>
</table>

➢ **Which competency domains?**

### Milestones

**Required Knowledge, skills, attitudes**

**Syllabus-Curriculum**

**Standards, Books, Legislations**
EPAs usually require multiple competencies in an integrative, holistic nature.

ten Cate & Scheele, 2007
EPAs require proficiency in several competency domains

- Patient care
- Medical knowledge
- Interpersonal skills & communic.
- Professionalism
- Practice-based learning & improv.
- System-based practice

Pangaro & ten Cate, 2013
EPA, Competency and Milestones

https://members.aamc.org
Linking EPAs to competencies

Tasks in real life

Competencies

Knowledge, skills, attitudes

Milestones

Instructional Materials/Format

EPAs

Implement and Feedback

Frank J. Med Teach, p.638. 2010
Competences; Milestones and Entrustable Professional Activities (EPAs)

Growth of competence over time

Dhaliwal U. 2015; Jonker G. 2014
## 7-item format of EPA description

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Title of the EPA</td>
</tr>
<tr>
<td>2</td>
<td>Specification and limitations</td>
</tr>
<tr>
<td>3</td>
<td>Most relevant domains of competence</td>
</tr>
<tr>
<td>4</td>
<td>Required experience, knowledge, skills, attitude and behavior for entrustment</td>
</tr>
<tr>
<td>5</td>
<td>Assessment information sources to assess progress and ground a summative entrustment decision</td>
</tr>
<tr>
<td>6</td>
<td>Entrustment for which level of supervision is to be reached at which stage of training?</td>
</tr>
<tr>
<td>7</td>
<td>Expiration date</td>
</tr>
</tbody>
</table>
## Example EPA description

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Verification of the new analyte</td>
</tr>
<tr>
<td>2</td>
<td>Includes: perform verification experiments, estimate of related measures, decide if it complies the requirements</td>
</tr>
<tr>
<td>3</td>
<td><strong>X QMS X</strong> Patient care X Medical Knowledge X Communicator</td>
</tr>
</tbody>
</table>
| 4 | **Knowledge**: basic knowledge of laboratory statistics, analytical and clinical performance characteristics; which guidelines used …  
**Skill**: skill in using necessary laboratory devices to perform verification experiments; computer skills and related statistical analysis; searching best evidence …  
**Attitude and behavior**: professional communication with the clinician, and related IVD vendor …  
**Experience**: done at least 5 times |
| 5 | Literature presentation; case-based discussions; real life experiments |
| 6 | **Supervision Level**: Level 4 proficiency level |
| 7 | **Expiration**: optional |
To empowerment of laboratory medicine specialists

- IFCC
- National societies
- National board exams
- IFCC: Worldwide assessment models
  - Tests or exams in digital media
A consensus curriculum for laboratory management training for pathology residents

<table>
<thead>
<tr>
<th>Topic</th>
<th>% of Programs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality assurance</td>
<td>51</td>
</tr>
<tr>
<td>Laboratory inspections</td>
<td>51</td>
</tr>
<tr>
<td>Regulatory affairs and accreditation</td>
<td>48</td>
</tr>
<tr>
<td>Test validation</td>
<td>43</td>
</tr>
<tr>
<td>Billing and compliance</td>
<td>40</td>
</tr>
<tr>
<td>Risk management</td>
<td>37</td>
</tr>
<tr>
<td>Test cost assessment</td>
<td>37</td>
</tr>
<tr>
<td>Capital equipment purchasing</td>
<td>37</td>
</tr>
<tr>
<td>Financial management and accounting</td>
<td>34</td>
</tr>
<tr>
<td>Leadership and management</td>
<td>32</td>
</tr>
</tbody>
</table>

The most common management topics covered

Weiss R. Et al., 2011
Exams can be for

- National board exams
- IFCC: Worldwide assessment model

Diagram:
- KNOWS (Knowledge)
- KNOWS HOW (Competence)
- DOES (Action)

- Behavior in the workplace
- Behavior in simulation exams
- Applied knowledge
- Factual knowledge
Worldwide standardized education and training in clinical chemistry and laboratory medicine

- challenging
- can be improved or harmonized by establishing an assessment modules based on the first two proficiency steps of the Miller’s Pyramid
- competency-based education approach
Thank you very much for your attention
Greetings from Pamukkale/Denizli