Assessment and evaluation in medical education
What does physiology teach us?

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“to develop physician thought leaders through inquiry, research and discovery, using an innovative curriculum based on adult learning methods in a patient centered context.”
Unified theory of practice, competence, readiness and evaluation in the clinical setting.

Embrace complexity, act with simplicity.
Defining curricular Success and Failure

A beginning intern from my medical school sees a patient with thyrotoxicosis who needs medication.
Simple program evaluation

• I would be happy if....

They could describe iodine metabolism and how methimazole worked.

Structure of Program Evaluation, TLM, 2007
Simple program evaluation

If not knowing these basic mechanisms, they did not fill this “gap”...

I would drop dead with embarrassment.
Faculty create Independence, Capability = ability to fill the gap

• What has to be internalized in the student?

• What is the role of faculty?

Independently learning from experience
An idea of success, a comparison

essential    desirable
Disclaimer and Disclosure

• The opinions and assertions expressed herein are mine and do not necessarily reflect the official policy or position of the Uniformed Services University or the Department of Defense.

• Harvard Macy Course in “Systems of Assessment in Medical Education” (honorarium).

• ACP book, Leadership Careers in Med Ed (royalty)
Terms as I will use them

• Learner, student .....resident, fellow

• Readiness = “competence” = capable of advancement towards independence

• “Assessment” = observing

• “Evaluation” = interpretation in context
Understanding Action

“Assessment” = observing

“Evaluation” = interpretation in context

“Grading” = administrative action
(advancement decision, summative)

Feedback = educational action
(formative)
What is “the end” = “physician”?
Question 1: What is a “physician”  
What’s the role of science in practice

• Physics, physiology, physician

• Physis = “nature”
Commitment to understanding mechanism at all levels

- Patient
- Systems
- Organs
- Cells
- Genes
- Molecules
- State/nation
- Society/organization
- Neighborhood/church
- Medical Home
- Caregiver/Family

Physician - physiology – physics

Physis = nature, process

Pangaro, JIAMSE, 2010; Med Sci Ed, 2022
Do physicians use basic science?

• Expertise as “encapsulation”
• The science is there, below the surface (Schmidt, Med Educ 2007)
  • Pathophysiology → illness scripts

• “Fast thinking” = pattern recognition
  • Polyuria-polydipsia
• Xray vision: osmotic diuresis
• “slow thinking” – figuring it out
the role of science in practice

• Promise of duty and expertise

• What is a commitment to understanding?

Emmanuele Chapentier  Jennifer Doudna

Nobel in Chemistry, 2020
CRISPR/Cas9 genetic scissors
Evolution and Revolution in Medical Education: Health System Sciences (HSS)

International Association of Medical Science Educators webinar series

- HSS = “Third Pillar” of Medical Education:
  - Dr. Gonzalo presented milestones between 1913 and
  - HSS framework is built on evidence and is patient-centered.

Rowe et al. Medical Science Educator (2021)
Building Health Systems Science Education from the Core Domain of Interprofessional Education at VTCSOM

- Building in systems thinking
- Interprofessional Education - Radford University Carillon
- Medical school curriculum mapping

- "mapping" = how faculty organize structure material
- How do students process and integrate?

Musick, Med Sci Educ, 2020
Mapping Knowledge as domains to understand

- Basic Science
  - Systems
  - Organs
  - Cells
  - Genes
  - Molecules

- Clinical Science
  - State/nation
  - Society/organization
  - Neighborhood/church
  - Medical Home
  - Caregiver/Family

- System Science

Pangaro, JIAMSE, 2010; Med Sci Ed, 2022
Integration → all levels → Systems thinking

HSS can be an invitation to use systems thinking in basic and clinical science as well.
What do these “sciences” have in common? basic, clinical and heath systems

• What is a system:

  ... “A collection of different things which, working together, produce a result not achievable by the things alone.”


Trying to maximize something, to avoid something, to protect something
Physiology as homeostasis

• Maximizing x (the system would be “happy if…”)
• Avoiding y (…would drop dead….literally)

• Maintenance of the internal milieu

• A set point
• Constant maintenance, constant dialogue about something really important

Claude Bernard
Physiology as homeostasis

• Maintenance of the internal milieu
  • MAINTAIN cerebral glucose
  • AVOID hypoglycemia

• Survival in order to thrive
What must the student internalize?

• At each ‘level’
• What must be **internalized**?
• What must be **developed**?
• What should be **maximized**?

• Expertise = capability to ask and answer these questions
• Duty = commitment to define and answer these questions
priorities in the three sciences:

**Basic science**
- Osmolality
- Glucose
- pH

**The Patient**
- My pain?
- My job?
- The cost?

**The care System**
- Safety
- Value
  - (Efficacy/cost)

Faculty: Can the student identify the priority at each “level”?
Professionalism is a promise of expertise and a promise of duty

Edmund Pellegrino

Kennedy Institute of Ethics J, 1995
Question 2: what does expertise look like?

Faculty judge:
What has the student internalized?

• Cognitive
• Understanding $\rightarrow$ action
Understanding ➔ Action

Reporter/Interpreter  Manager/Educator

Cognitive  Ethical

Expertise > Duty  Expertise = Duty
What is understanding? What is knowledge?

Understanding → Action

Observation → Reflection → Action

Knowledge
Sampling
Values

Data → Information → Certainty → Wisdom

Observe the resident → Teacher Feedback → Many observations → Competency Committee
Cognitive progress

- Create, study, extend
- Evaluate and make decisions
- Apply and Justify
- Explain
- Remember as True

Bloom’s Taxonomy revised x2
Q3. What is knowledge?

Data → Information → Certainty → Wisdom

"Justified true belief"
Knowledge ("JTB") as the bedrock of U → A

• “True”: the student must remember accurately and report it accurately

• “Justified”: the student must apply it to a situation and interpret findings accurately

• “Belief”: there is a commitment to acting, basing management on it, an emotion of confidence to risk a patient’s health.
  • When that confidence is absent, I need to learn more!
“What Do I Need to Know?”

• About a test
  • How does it work? (physiology and/or anatomy)
  • How good is it?
  • How “bad” is it?

• About a disease or syndrome

• About a therapy

Internalize this concept:
Can the student ask and answer:
What does adequate knowledge look like?

Self-regulated learning
Metacognition
Reflection-in-action
Understanding → Action

Curriculum = a series of invitations that fosters this progress

Reporter
Interpreter
Manager/Educator
Q4. But what is action?

• Moving from Understanding into Shared decision making
• Being a “Manager”
  • Sub-intern: suggesting plans
  • Resident: effective, safe plan
• Applying ‘knowledge’ to specific situations
Where and how is understanding formed?

Understanding → Action

- Ethical > Cognitive
- Context of the patient’s life and the world in which they live
- Criticality of systems thinking
clinical science begins with real patients

• This has been accomplished by actual student-patient contact under preceptor supervision in ambulatory clinic settings, nursing homes, hospice centers, etc., as well as more use of standardized patients.  

Vari, Advan in Physio Ed, 2002

• At the Virginia Tech Carilion School of Medicine, clinical science begins with real patients—and in the first week of school

➢ This takes dedicated clinical faculty
➢ “faculty” = create capability
“20th century” models

• *Flexner Report (Carnegie I) = “2 +2”*

• *Exclusively apprenticeship model → academic model*

_Flexner Revisited: The Role and Value of the Basic Sciences in Medical Education_

Understanding → Action

**MS-I**
- Pre Clerkship Instruction
- Pre Clerkship Instruction

**MS-II**
- Pre Clerkship Instruction
- Basic Core Clerkship Block
- Core Clerkship Block

**MS-III**
- Core Clerkship Block
- Core Clerkship Block
- Step I Prep Exam
- Advanced Didactics
- Advanced Clinical Rotations

**MS-IV**
- Adv. Clinical Rotation
- Admin/Step II
- Adv Clinical Rotation
- Capstone Project
- Clinical Electives and/or Continuation of Capstone

**Additional Notes:**
- January 2013
- January 2014
- October 2014
- 1 May 2015
- Vacation
Bronfenbrenner: the environmental framework

Goal to be internalized: the patient’s universe

The patient (child) at the center

System levels
“Chrono”
“Macro”
“Exo”
“Meso”
“Micro”

Bronfenbrenner: the environmental framework

Can understanding be formed in the context of the classroom?

Alternatives:
- Spiral curricula
- VTCSOM’s method
- Abandon Flexner’s 2+2 ?
Q5. Evaluation of expertise and duty
Judgment about success in JTB and application?

Evaluation – importance, “strength”, capability

the “strength” we have in mind, the purpose

➢ Is this resident building capability?
➢ Is there progress toward independence?
➢ Internalization of an idea of expertise and duty?
Q.6 : What is the capability we must create?

• An internalized "set point"

• A standard against which learners judge their current performance?
  • “What they did”, not “who they are”.

• A mental model of what expertise and duty look like

• Preclerkship = developing “JTB”

• Clinical years = moving from understanding to action
What “capability”? 

• “Train” to what’s common, typical and predictable; guidelines work  
  • Probably don’t need physicians for simple problems in simple patients  

• “Educate” for the unpredictable, complex, rare; need to figure it out and use shared decision making.
Competence defined (analytic framework)

The habitual and judicious use of communication, knowledge, technical skills, clinical reasoning, emotions, values, and reflection in daily practice for the benefit of the individual and the community being served.

Epstein, Hundert, JAmrMedAssoc, 2002
Competence Defined Synthetically

The ability to give to each situation all that belongs to that situation, and no more.

Pangaro, Med Teach, 2000
Capability = thinking, reasoning, decision making

Commonality of assessment frameworks

• Observation $\rightarrow$ Reflection $\rightarrow$ Action
• Data $\rightarrow$ Information $\rightarrow$ Knowledge $\rightarrow$ Wisdom
• Reporter/Interpreter $\rightarrow$ Manager/Educator
What about ACGME Milestones?

Make the six competencies 23 sub-competencies “understandable”

- 23 Milestones
- Five stages each
- 3 - 5 behavioral anchors per stage
Internal Medicine PC milestones {needs expert judgment}

<table>
<thead>
<tr>
<th>Critical Deficiencies</th>
<th>Observer</th>
<th>Reporter</th>
<th>Interpreter</th>
<th>Ready for unsupervised practice</th>
<th>Aspirational</th>
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</thead>
<tbody>
<tr>
<td>Does not collect</td>
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<tr>
<td>accurate historical</td>
<td>Inconsistently able to acquire accurate historical information in an organized fashion</td>
<td>Consistently acquires accurate and relevant histories from patients</td>
<td>Acquires accurate histories from patients in an efficient, prioritized, and hypothesis-driven fashion</td>
<td>Obtains relevant historical subtleties, including sensitive information that informs the differential diagnosis</td>
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<tr>
<td>data</td>
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<td>Does not use physical</td>
<td>Does not perform an appropriately thorough physical exam or misses key physical exam findings</td>
<td>Seeks and obtains data from secondary sources when needed</td>
<td>Performs accurate physical exams that are targeted to the patient’s complaints</td>
<td>Identifies subtle or unusual physical exam findings</td>
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<tr>
<td>exam to confirm history</td>
<td>Does not seek or is overly reliant on secondary data</td>
<td>Consistently performs accurate and appropriately thorough physical exams</td>
<td>Efficiently utilizes all sources of secondary data to inform differential diagnosis</td>
<td>Role models and teaches the effective use of history and physical examination skills to minimize the need for further diagnostic testing</td>
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<tr>
<td>data is generated</td>
<td>Inconsistently recognizes patients’ central clinical problem or develops limited differential diagnoses</td>
<td>Uses collected data to define a patient’s central clinical problem(s)</td>
<td>Effectively uses history and physical examination skills to minimize the need for further diagnostic testing</td>
<td>I/early M</td>
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<td>own database or</td>
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<td>differential diagnosis</td>
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<td>Fails to recognize</td>
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<td>patient’s central</td>
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<td>clinical problems</td>
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<td>Fails to recognize</td>
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<td>potentially life</td>
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<td>threatening problems</td>
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</table>

Can we simplify this?
## Obstetrics

### Antepartum Care and Complications of Pregnancy — Patient Care

<table>
<thead>
<tr>
<th>Level</th>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Reporter</td>
<td>Demonstrates basic knowledge of normal obstetrical care and common medical complications seen in pregnancy</td>
</tr>
<tr>
<td>2</td>
<td>Manager</td>
<td>Provides complete antepartum care for women with uncomplicated pregnancies M</td>
</tr>
<tr>
<td>3</td>
<td>M/E</td>
<td>Manages common medical complications (e.g., hypertension, diabetes, infectious diseases)</td>
</tr>
<tr>
<td>4</td>
<td>Int, advanced M</td>
<td>Manages common obstetrical complications (e.g., previous Cesarean section, abnormal fetal growth, multifetal gestation)</td>
</tr>
<tr>
<td>5</td>
<td>Advanced M</td>
<td>Manages patients with complex and atypical medical and obstetrical complications</td>
</tr>
</tbody>
</table>

### RIME-stones (Hemmer)

<table>
<thead>
<tr>
<th>Level</th>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Reporter</td>
<td>Recognizes basic risk factors, symptoms, and signs of common medical complications (e.g., hypertension, diabetes, infectious diseases)</td>
</tr>
<tr>
<td>2</td>
<td>M/E</td>
<td>Effectively supervises and educates lower level residents in antepartum care</td>
</tr>
</tbody>
</table>

Pangaro 2020
Frame of Reference

**Performance Dimensions**

**REPORTER**
- Gather a history and perform a physical exam
- Document a clinical encounter in the patient record
- Provide an oral presentation of a clinical encounter
- Collaborate as a member of an interprofessional team

**INTERPRETER**
- Prioritize a differential diagnosis following a clinical encounter
- Recognize a patient requiring urgent or emergent care
- Recommend* and interpret common diagnostic and screening tests

**MANAGER**
- Enter and discuss orders and prescriptions
- Give or receive a patient handover to transition care responsibility
- Obtain informed consent for tests and/or procedures
- Perform the general procedures of a physician

**EDUCATOR**
- Form clinical questions and retrieve evidence
- Identify system failures and contribute to safety and improvement
“MODERN MEDICAL CURRICULA”

• Pedagogy has changed to focus more on student-centered learning vs. faculty-centered delivery
  • more case discussions,
  • problem-based learning instead of more traditional didactic presentations.

What should be the content of these conversations?

• Vari, Advances in Physiol Educ, 2001
Simple evaluation of learner knowledge

• Teacher should be happy if....

They could describe iodine metabolism and how methimazole worked.
evaluation of whether the expectation (set point) has been internalized

If not knowing these basic mechanisms, they were not restless until they filled the gap

1. Recognizes the gap
2. Has a concept of adequate knowledge
3. Search strategy
4. Commitment

KSA
How does the system coordinate itself?

- Multiple teachers at the same site
- Fewer weeks together
- Inter-teacher consistency
- System problem – getting teachers on the same page

Student’s perspective, Armstrong, Harvard Macy Institute
“a crap shoot” for students?
Evaluation = Professionalism

• Professionalism = promise
  • of expertise and duty
  • faculty promise expertise and duty in evaluation

• If a learner cannot trust the faculty’s evaluations, then what does “professionalism” mean?
Evaluation = professionalism

- to society: competence (P/F)
- to students: transparency, feedback and trust of faculty
- to teachers: time and training; ‘protection’ (emotional and career)
Feedback to learners

• I would be happy if....

The feedback I gave a student today helped her with her next medicine attending.
Feedback to learners

If the feedback I have a student made things worse with his next attending! I would drop dead with embarrassment if....
Q.7: How does physiology help?

Faculty are the observers
- What is the faculty’s ‘set point’ for expectations?
- Construct alignment across teachers

- Physiologic communication
  - Receptors
  - ”processing”
  - Response = action
Re-imagining Faculty Development in Health Professions Education

• “communities of practice create longitudinal spaces where relationships are formed over time towards a common goal”.

• What is an “educator”?
  • Ex-ducere = to lead out of (dependence) into independence (readiness)
  • Communicating knowledge, explaining decisions
  • Creating capability

The goal: progressive independence

After Stanford Faculty Development Center
Q.9: what is physiologic communication

• Anatomy: afferent $\rightarrow$ spinal reflex $\rightarrow$ efferent

Three phases:
1. Signal received
2. Integration
3. Response
What is physiologic communication

• Chemical: receptor → processing → cellular change

Three phases:
1. Receptor
2. Intracellular processing
3. Cell signaling
A final plea for simplicity.

Fairness to faculty.
The rhythm is simple and always the same!

<table>
<thead>
<tr>
<th>H&amp;P</th>
<th>S.0</th>
<th>Reporter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessment..</td>
<td>A-------</td>
<td>Interpreter</td>
</tr>
<tr>
<td>Plan............</td>
<td>P-------</td>
<td>Manager/ Educator</td>
</tr>
</tbody>
</table>
Simplicity : Communication = “Neurotransmitters”
dopamine

MW = 150.
Immunoglobulin

MW = 150,000
ACGME “Competencies”

• Medical Knowledge
• Interpersonal & communication skills
• Professionalism
• Patient Care
• Practice-based learning & Improvement
• System-based Practice
“MW” = 150,000
Smaller molecules to communicate?

- 6 competencies
- 13 EPAs
- 23 subcompetencies
- 23 milestones
The Rhythm

The Details ("EPAs")

REPORTER
- Gather a history and perform a physical exam
- Document a clinical encounter in the patient record
- Provide an oral presentation of a clinical encounter
- Collaborate as a member of an interprofessional team

INTERPRETER
- Prioritize a differential diagnosis following a clinical encounter
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- Perform the general procedures of a physician

EDUCATOR
- Form clinical questions and retrieve evidence
- Identify system failures and contribute to safety and improvement
A mental model, concept for expected GME progress toward independence

x = proficiency with a patient
Not just improving but “ready” in all core problems

Everything in the core for your specialty

Is this in the core for your specialty?

Not just improving but “ready” in all core problems

Everything in the core for your specialty

Is this in the core for your specialty?
The Lessons of physiology – unifying ideas

• Expect understanding of mechanisms
• Build capability
  ➢ Internalize a physiologic set point for what expertise and duty and duty look like
• Framework
  ➢ use the mental models for which clinicians already have “receptors”
    ❖ The rhythm of RIME
Embrace complexity, act with simplicity.
Thank you, Rick!
Thank you for the privilege

• louispangaro@aol.com

• Please write if further conversation will help

• Annotated bibliography for RIME system also posted.