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Science and Craft in Educating Health Professionals: The Role of Clinical Reasoning

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Center for Cognitive Informatics & Decision Making

Outline

- A skilled practitioner and development of expertise
- Evidence supporting role of Basic science for clinical practice
- Development of reasoning skills and its implication for education and training
- Implications for role of basic science and clinical reasoning skills in health professionals curicula

Focus on Types on Learning

- Practice-based apprentice (Early 1920s)
  - Skilled craftsman
- Science -based learning (Post 1910)
  - Good scientific practitioner
- Problem-based learning (1970s)
  - Good practitioner and problem solver

Skilled Practitioner (Expert)

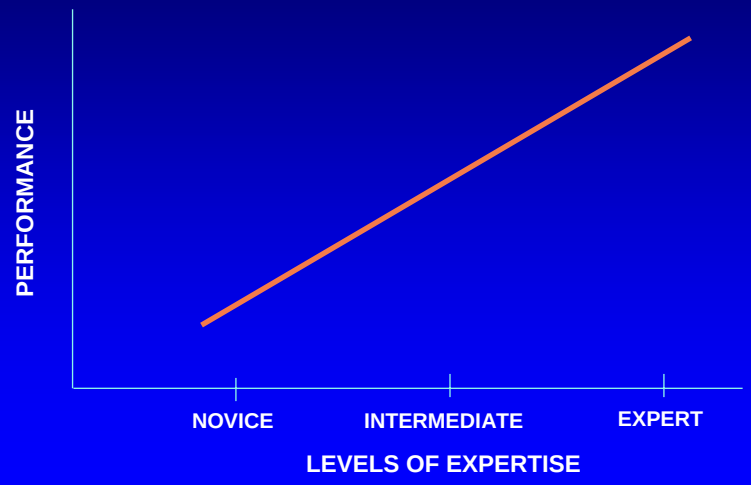
- Organized knowledge of the domain (facts are all connected)
- Well developed and efficient reasoning strategies
- Flexible and adaptive in solving problems
- Self-reflective, meta-cognitive capabilities

Development of Expertise

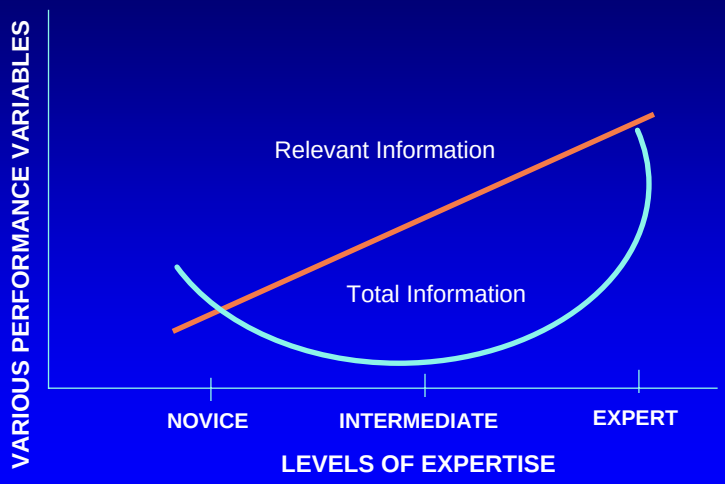
- During training, performance gets worse before it gets better
- Performance degradation is a function of knowledge reorganization or lack thereof
- This is a universal phenomenon that is task- and situation-invariant

Patel, V.L., Arocha, J.F. & Kaufman, D.R. (1994) Diagnostic Reasoning and Expertise. *The Psychology of Learning and Motivation: Advances in Research and Theory, 31,* 137-252.

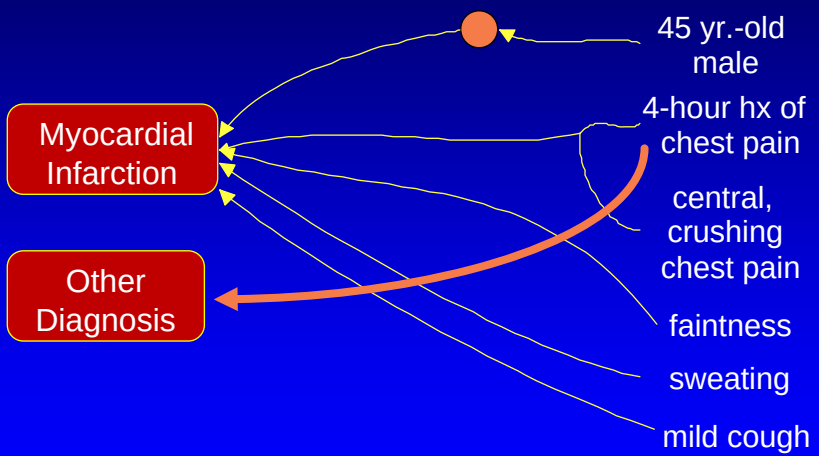
Presumed Development of Expertise



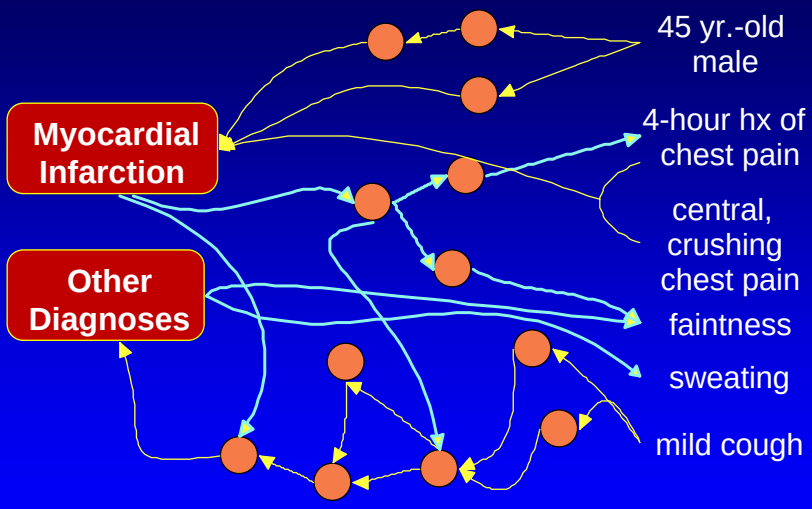
Non-Monotonic Development



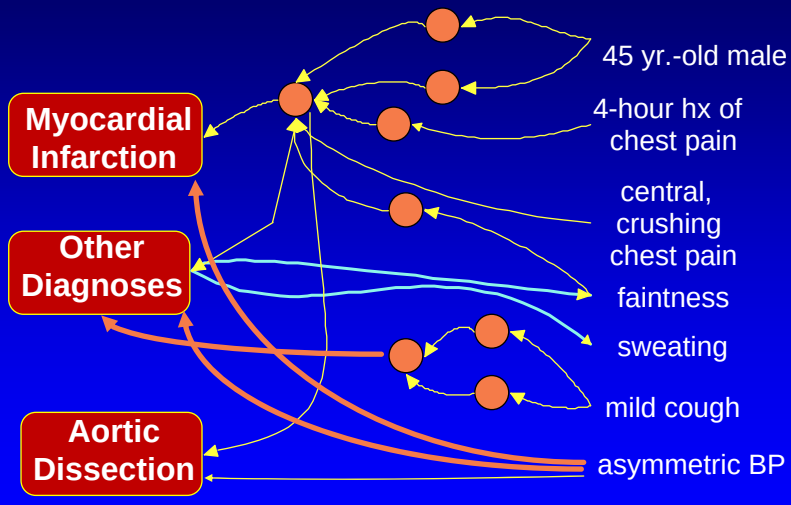
Case Interpretation by Novice Clinician



Case Interpretation by Intermediate Clinician



Case Interpretation by Senior Clinician



Evidence Supporting the Role of Basic Medical Science in Clinical Practice

Patel, V.L., Groen, G.J., & Norman, G.R. (1993) Reasoning and instruction in medical curricula. Cognition & Instruction, 10(4), 335-378.

Studies of Curriculum and Instruction

Rationale for Problem Based Learning Curriculum (PBLC):

- **Integration of biomedical and clinical knowledge**
- **Development of clinical reasoning processes**

Study Design

- Students from PBLC and conventional curriculum (CC)
- Clinical problem and three related biomedical information topics
- Group 1: Biomedical and then clinical
- Group 2:
  - Clinical only
  - Basic-science information added
- Each group: Beginning, intermediate and senior students

Study Design 2

- Clinical problem:
  - Acute Bacterial Endocarditis
- Biomedical texts:
  - Physiology of fever
  - Hemodynamics
  - Microcirculation

Major Findings: Basic Science Before Clinical Problems

- Both PBLC and CC students did not perform well
- Basic Science was not well-integrated into clinical problem
- Too much basic science at the beginning of the curriculum did not help integration

Major Findings: Clinical Problem Alone

- PBLC: Used biomedical information
  - Biomedical and clinical information were integrated
  - PBL training influenced use of BS even when no BS was necessary in solving problems
- CC: Used only clinical information
  - Biomedical and clinical information were separate
  - CC training influenced use of clinical information with no BS

Major Findings:
Basic Science After the Clinical Problem

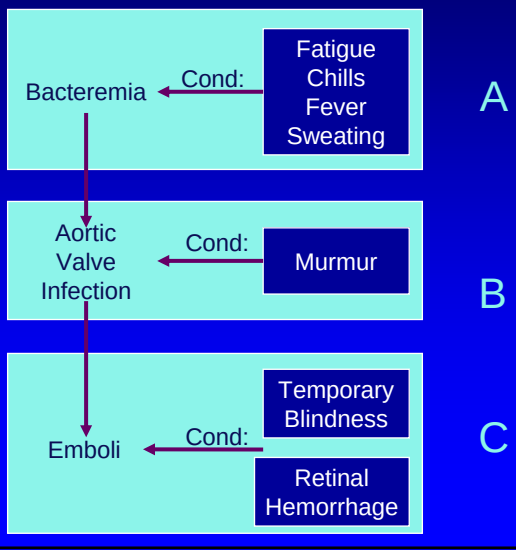
- PBLC: Biomedical information used in great detail
  - Fragmented knowledge structures and generation of errors
- CC: Little biomedical information used only to support clinical information
  - Knowledge structure coherent

Patel, V.L., Evans, D.A. & Groen, G.J. (1989) On reconciling basic science and clinical reasoning. Teaching & Learning in Medicine: An International Journal, 1(3), 116-121.

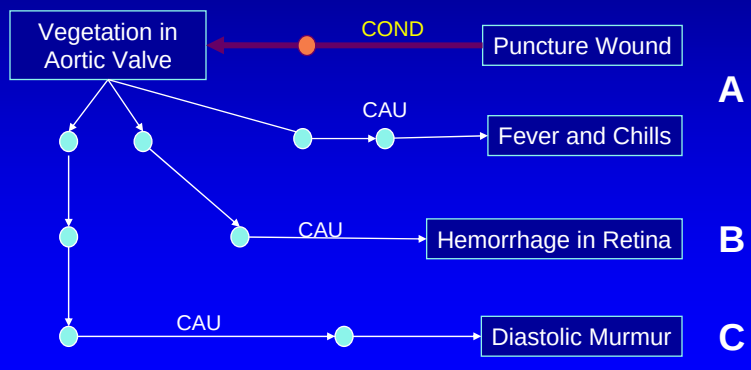
Protocol:
Final Year Medical Student - CC

Bacteremia resulting in generalized symptoms of illness, i.e., fatigue, chills, fever, sweating. These bacteria accumulated in aortic valve with resultant vegetations and murmur due to occlusion of valve. Emboli from these vegetations travel via carotid on left to left retinal artery resulting in temporary blindness and flame hemorrhages due to the occluded blood supply.

Schematic Representation of Patient Problem Explained by Senior Medical Student (Clinical Text, CC)



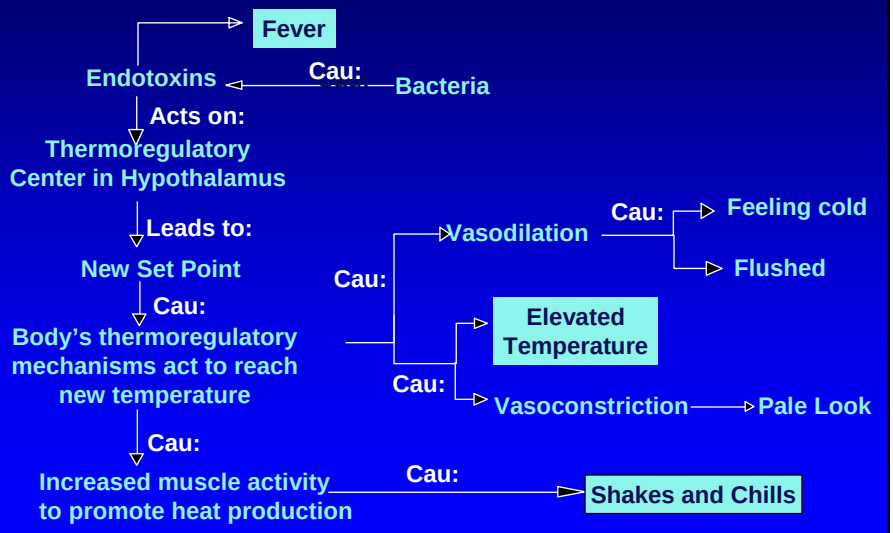
Schematic Representation of Patient Problem Explained by Senior Student (Clinical Text + Basic Science, CC)



Explanation of Endocarditis Problem (Senior medical student in the PBL school, when exposed to clinical text only in the PBL School)

- The patient's circulatory distress appears to be related to systemic vasodilation.
- This could explain the wide pulse pressure with low systolic and diastolic levels and the bounding and disappearing pulse.
- Because flow (cardiac output, which hear rate = stroke x volume) is proportionate to blood pressure over resistance, any drop in total peripheral resistance would require the heart to increase stroke volume and/or heart rate in order to maintain blood pressure at a reasonable level. Thus, the heart rate increases to (120 beats per minute)
- And a diastolic murmur is heard, which may be indicative of increased filling to the left ventricle (i.e., a large amount of blood running across the mitral valve, although one would suspect a third heart sound rather than a murmur).

Problem Representation of Endocarditis by Senior Medical Student (PBL): Problem + Basic Science Texts



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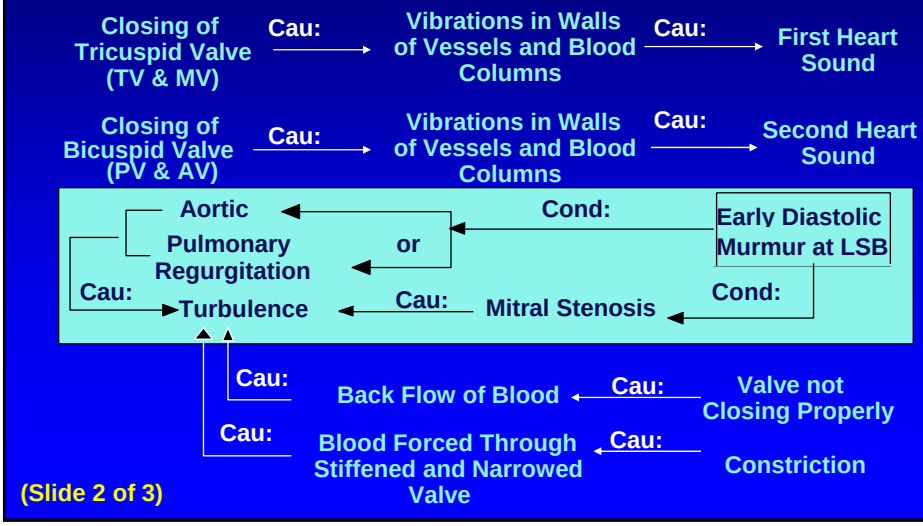
Problem Representation of Endocarditis by Senior Medical Student (PBL): Problem & Basic Science Texts



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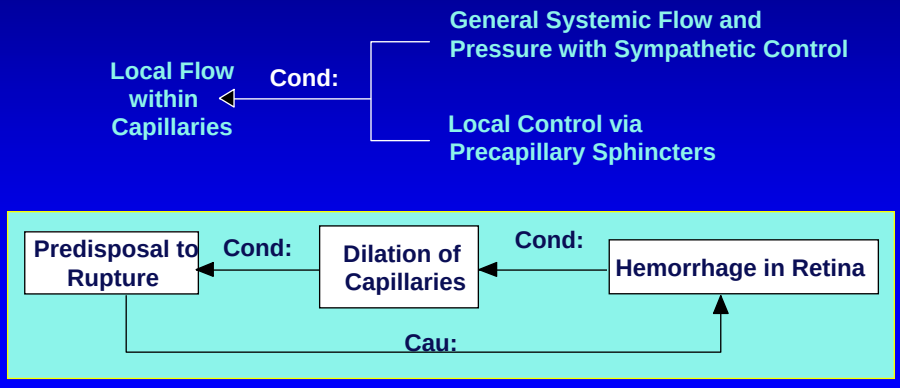
Problem Representation of Endocarditis by Senior Medical Student (PBL): Problem & Basic Science Texts



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Major Findings (3)

Directionality of reasoning

- **BS in clinical context only with little "hands on" practice training**: hypothesis-driven and elaborations
  - Multiple diagnostic hypotheses
  - Inefficient and less confident
  - If errors, easy to eradicate
- **BS separated and intensive bedside training**: Data-driven with little or no elaborations
  - Fewer selected diagnostic hypotheses
  - Efficient and confident
  - If errors, difficult to eradicate

Long Term Effect of Science-Based and Problem -Based Medical Training

Experiment 2

- Studies of residents trained in CC and PBLC
- Two clinical problems with two levels of complexity
- Task: summarize, explain and diagnose the clinical problems

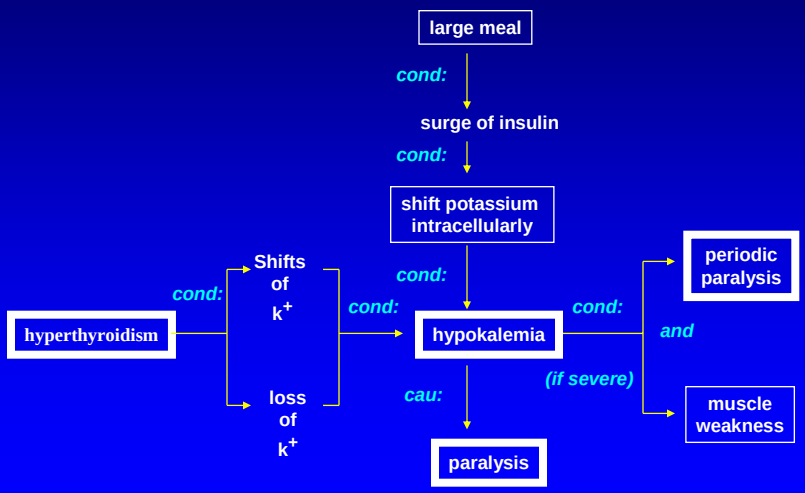
Patel, V.L., Arocha, J. Lecissi,M (2001). Impact of Undergraduate Medical Training on Housestaff Problem Solving Performance, Implications for Health Education in Problem- based Curricula." Journal of Dental Education; 65 (11) 1199-1218.

Long Term Effect of PBL: Major Findings

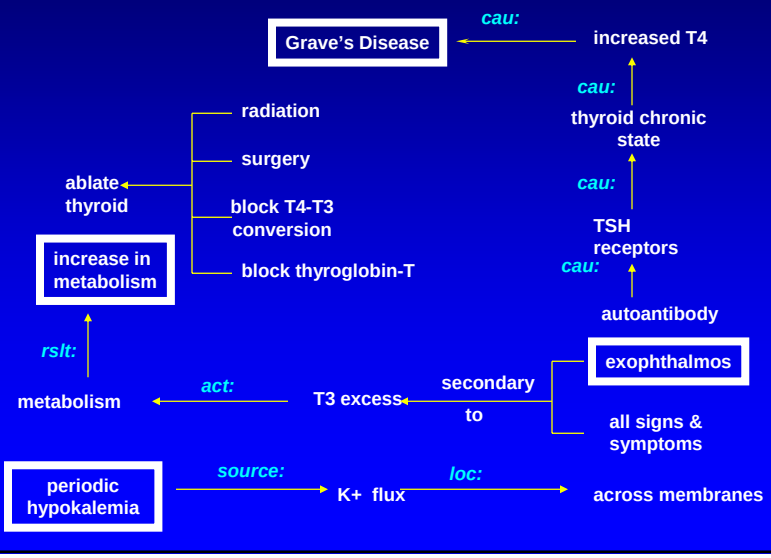
- PBLC
  - Integrated biomedical and clinical knowledge
  - Low use of data-driven strategies
  - Use of hypothesis-driven strategies and elaborations
- CC
  - More integration of biomedical and clinical knowledge
  - Some use of hypothesis-driven strategies
  - Some use of elaborations

Data driven heuristics were not easily acquired in PBLC

Semantic Representation of the Pathophysiological Explanation for Case 1 by a Resident from the CC



Semantic Representation of the Pathophysiological Explanation for Case 1 by a Resident from the PBLC



Summary : Scientist-Practitioner and Master Craftsman Models

- Data driven heuristic strategies, which are hallmarks of skilled craftsmen cannot be easily taught explicitly
  - They must be acquired through implicit learning through exposure to real-life situations (clinical anomalies activate use of basic clinical science)
- Basic science (BS), when tightly integrated with clinical information, interferes with the utility of routine diagnostic reasoning
  - BS is useful in non-routine, complex situations
  - Basic sciences act as a "glue" to bind the clinical information and helps remember clinical stories.
- Basic science information although not overtly used by health professionals, does stay dormant until activated

Implications

- Not all basic science can be taught in the clinical context
  - Over-contextualization interferes with abstract learning and transfer
  - Must demonstrate generalizability (and encourage flexibility of thinking) with multiple problem sets
  - Core basic concepts needed at beginning of the curriculum with early introduction of Clinical exposure
- Problem solving with paper and pencil is not the same as real-life experience
  - Confirms importance of internship experiences as key learning elements
- Argues for real life simulation environments for training

Development of New Human Abilities to Consider in Technology-Related Environment

- Managing cognitive load
  - Increases with integration of knowledge from different sources
- Training of higher order problem solving, reasoning and judgmental skills, as simple task will be taken over by technology
  - Long term investment on our most valuable resource: the Human Mind
- Recognize relation between education and training
  - Training is not enough (necessary, not sufficient)
  - Must educate to support training

Thank You

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