

Low Hanging Fruit....

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Abstract

The low hanging fruit to decrease the cost of patient care is to educate medical students, residents and hospitalists in schema-based reasoning. This methodology of medical problem solving was developed at the University of Calgary Medical School in the 1980s to guide beginners to achieve a higher probability of diagnostic success. It grew out of a simple question by Henry Mandin M.D. who asked, "How can we teach Beginners to think like Experts?" For his work Dr. Mandin was awarded the Duncan Graham Award for Canadian Medical Educator of the year and the Boerhaave Award for International Medical Educator of the year.

"We are all Beginners,

We are all Experts"

PURPOSE

1. Discuss the definition of efficiency in business and specifically in medicine.
2. Explain how Expert physicians achieve diagnostic success?
3. How do medical schools employ clinical cases to achieve diagnostic success in beginners?
4. Has one method been shown superior to the other to achieve diagnostic success?
5. Can physicians previously trained in hypothetical-deductive reasoning adapt schema-based reasoning?

DISCUSSION OF EFFICIENCY

In business, efficiency has only one definition: $\frac{\text{Output}}{\text{Input}}$

In medicine this equation is rewritten as:

$$\frac{\text{Good patient care}}{\text{Costs}}$$

The numerator of the equation, good patient care is non-negotiable. The only way to become more efficient is to decrease the denominator, to decrease the inputs. The inputs

in medicine are non-monetary and monetary. The non-monetary costs include physical risks to patients, time of physicians and nursing staff, time spent by patients and their families for tests and visits, loss of patient wages, as well as physical and emotional stress on patients and families. Monetary costs include fixed and variable costs. Fixed medical costs include capitalization costs for hospitals, clinics, and major equipment to include payment of principle and interest, and insurance. These costs are negotiated to be repaid over years and have very little effect over a short period of time. Variable medical costs include salaries, laboratory test reagents, radiology films and discs, disposable surgical equipment, and all medications. Variable monetary costs can be broken down into the cost of each unit of a good or service x the number of units of that good or service. For example: the total cost for a single course of Vancomycin antibiotic is the cost of one gram of Vancomycin times the number of grams needed to treat a particular infection. Here there is some room to decrease negotiated costs and rebates. But what if the diagnosis is wrong? The most expensive diagnosis is the wrong diagnosis. It happens.

Laura Landro in the Wall Street Journal (WSJ) November 18, 2013 writes, "Missed diagnoses are among the most common, costly and harmful medical errors. But they are also some of the most preventable."¹

James B. Lieber writing in the WSJ May 17, 2016 states, “How to Make Hospitals Less Deadly?... The problem takes many forms: misdiagnosis, delayed diagnosis, partial diagnosis and over diagnosis. Mistakes flow from physician bias, knowledge gaps and a lack of teamwork. Clinicians cannot keep up with the exploding array of molecular, genetic and imaging technologies.”²

But it is Danielle Ofri’s writing that is the most poignant in its frustration. Dr. Ofri MD writes, “Recently I had one of those bursting-at-the-seams types of days in the clinic. Every scheduled patient showed up, plus a few extras. Everybody seemed to have burning concerns that needed immediate attention... For each of these presenting symptoms there can be a gamut of possible causes — what doctors call the “differential diagnosis” — that run from the prosaically benign to the concernedly urgent to the immediately life-threatening. The goal is to come up with a broad differential for each symptom, then prioritize them by likelihood and by severity... If I had the luxury of an hour with each patient, I would have the time to carefully sort through every possibility. But the reality is that I, like most doctors, have five to 10 minutes to push the majority of diagnoses to the bottom of the list, come up with the most likely few at the top — being careful, of course, to keep in the rare but life-threatening possibilities — and then explain to the patient what I think.”³

So, in Dr. Ofri’s world it is time, or the lack of it, that is the limiting factor. Her equation for efficiency becomes:

$$\text{Efficiency} = \frac{\text{Patient outcome}}{\text{Time}}$$

She also writes about the use of check lists of possible diagnoses. “There are now dozens of so-called symptom checkers on the Internet that allow you to enter your symptoms and come up with your own differential diagnosis. But are they accurate?”

A study evaluating 23 different symptom checkers used in the United Kingdom, United States, the Netherlands and Poland found the following:

- Overall, the correct diagnosis was listed first in 34% of standardized patient evaluations
- In emergent standardized patient evaluations, the correct diagnosis was listed 24%
- Non-emergent standardized patient evaluations the correct diagnosis was 38%
- Self-care standardized patient evaluations the correct diagnosis 40%.⁴

These findings beg the question: as a patient am I willing to accept the risks and costs associated with these low diagnostic yields?

*It is my belief that the **Low Hanging Fruit** to decrease medical care costs, to decrease risks, and to increase efficiency in medical care delivery is to use forward thinking inductive schema-based reasoning.*

For the purposes of this report I have defined the terms Experts and Beginners as follows. Experts are health care professionals who possess significant medical content knowledge and schema- based reasoning processes. Beginners are health care professionals who possess various degrees of medical content knowledge and who are transitioning to schema-based reasoning. Others have defined “Experts” as qualified specialists practicing their specialty for more than five years and “non-experts” (Beginners) as final year clinical clerks.⁵

HOW DO EXPERT PHYSICIANS ACHIEVE DIAGNOSTIC SUCCESS?

In our everyday worlds, knowingly or not, all of us employ efficient step-wise strategies to make daily decisions and to solve new problems. These strategies include pattern recognition, schema-based reasoning and hypothetico-deductive reasoning. Over the past 100 years medical educators have applied these three strategies to develop medical education curricula.

The first strategy employed by all of us and to include Expert physicians is **pattern recognition**. Sir William Osler M.D. (1849-1919) noted that pattern recognition forms a critical part of the diagnostic process and that the clinician draws on his knowledge base to refine a possible diagnosis from various “triggers.”⁶

Bowen wrote that, “Expert clinicians store and recall knowledge as diseases, conditions, or syndromes — ‘illness scripts’ — that are connected to the clinical problem for which the patient presented. These representations trigger clinical memory, permitting the related knowledge to become accessible for reasoning.”⁷

We would recognize our own "patterns" as good habits allowing us to navigate and remain safe in our everyday world.

The second strategy used by all of us and to include Experts

is **schema-based reasoning**. This is an inductive reasoning process which employs a series of questions and answers in which key features are used to include or exclude sets of possibilities. Dr. Henry Mandin MD at the University of Calgary, Alberta, Canada combined Experts' questions and answers describing how patients present to a physician with patho-physiological principles (anatomy, physiology, and pathology) to produce 124 schemes, the basis of the Clinical Presentation (CP) Curriculum. In describing a scheme, Dr. Mandin wrote, "Schemes are created by Experts and are considered to have two functions; to serve as frameworks around which students could learn new information (chunking) and to provide an approach to clinical problem solving."⁸

In summary, one progresses in a step-wise manner from data to diagnosis; from what is absolutely known to be true from the history, physical (anatomy), and physiology to diagnosis. It is also called inductive reasoning.

The third strategy used by all of us to include Experts is **hypothetico-deductive reasoning**. This is a process whereby all possible hypotheses are formulated and tested in a sequential fashion. This method was employed by the Greeks, used by a majority of physicians at the turn of the last century, and evaluated by Elstein, "The utilization of a hypothetical-deductive method seems to be a nearly universal characteristic of human thinking in complex, poorly defined environments."⁹

This third method of reasoning works well in binary systems; such as, is the universe expanding or contracting? However, in complex systems with hundreds of possible answers such as "Weakness", (see below) this method frequently falls short. It requires that "**all** possible hypotheses be formulated and tested". If the final diagnosis is not included in the initial hypotheses, then it is missed 80% of the time. Think of Dr. House, wonderful theater, but terrible medicine.

ACHIEVING DIAGNOSTIC SUCCESS-BEGINNERS

Achieving diagnostic success is a core competency for all physicians.¹⁰ This has always been true. However, there has been an evolution over the past century in how this goal is achieved. Published in 1910, the Flexner report precipitated the reorganization of medical education in the United States. It "embraced scientific knowledge and its advancement as the defining ethos of a modern physician. Such an orientation had its origins in the enchantment with German

medical education." Medical schools developed a basic sciences first approach. They became standardized at four years with the first two years stressing the basic sciences and the last two years employing clinical rotations in hospitals and out-patient settings. This became known as "the 2+2 stack model".¹¹ Overtime it was realized that the Flexner report had under emphasized the primary role of physicians as beneficial healers.¹² To correct this deficiency, to facilitate the grouping of large chunks of scientific knowledge, and to foster diagnostic success in solving clinical problems all medical schools integrated clinical cases into the curricula of medical students' basic science years. In the analysis of these clinical cases knowing factual material was considered of secondary importance and the ability to solve medical problems became the primary goal of medical education.⁷

Experts have available to themselves the use of all three reasoning strategies and do so in a sequential organized manner. But Beginners are not yet Experts. They can only employ schema-based and hypothetico-deductive reasoning.¹² Medical schools have available both of these strategies to teach Beginners. But here medical schools differ in how they facilitate case presentations, analysis of cases, and diagnostic approaches. For example, in Phoenix, Arizona, US; A.T. Still University uses the schema-based reasoning approach mentored by osteopathic (DO) and allopathic physicians (MD), while the University of Arizona College of Medicine-Phoenix employs hypothetical-deductive reasoning in clinical cases mentored by PhDs or MDs. The University of Edmonton Medical School in Alberta, Canada employs hypothetical-deductive reasoning in its clinical cases and only MDs for all clinical cases and all teaching of basic sciences. The University of Calgary, the other medical school in the province of Alberta, originated and still employs schema based reasoning within its Clinical Presentation Model (CP).

HAS ONE METHOD BEEN SHOWN TO BE SUPERIOR TO THE OTHER IN ACHIEVING DIAGNOSTIC SUCCESS?

Curricula employing either method equally prepare students for the medical knowledge content portions of Board examinations, and both encourage critical thinking. However, these two strategies are not the same and do not have equivalent outcomes in achieving diagnostic success. The evidence favors schema-based reasoning. Studies to support this are as follows:

- Patel and Groen determined that experts who

accurately diagnosed complex clinical problems used forward reasoning (schema-based reasoning, data to diagnosis) in contrast to novice subjects (their term for Beginners) who used backward reasoning (hypothetical-deductive reasoning, hypothesis to data). The novices more often misdiagnosed or only partially diagnosed the same presenting problems.⁷

- Mylopoulos studied the qualities of renowned clinicians as judged by their colleagues. He concluded that these experts were noted for their ability to gather meaningful patient stories (illness scripts) through series of questions and answers (scheme-based reasoning).¹⁴
- Four independent studies from the University of Calgary have showed the benefits of schema-based reasoning on the retention of experts' long term knowledge as well as on the retention of basic scientific knowledge and diagnostic success by Beginners.^{5,15-17}
- The University of Toronto Medical School in a prospective, randomized, controlled study compared these two methods in medical students. Their findings, "Diagnostic success was higher in the schema-based instruction group for taught lessons (mean difference equal to 38%, 95% confidence interval, $p < 0.001$) and students employing schema-based instruction performed better on unstructured knowledge questions. The two groups did not differ in learning time, accuracy, nor factual knowledge questions."^{18, 19}
- The emergence of "second victims": Van Gerven studied 5788 health care professionals (20.6% physicians) in 37 acute care Belgian hospitals. He discusses the increased risk of burnout for physicians and nurses involved in a patient safety incident and writes, "Human error in health care is a widespread concern". But what if we could improve the odds of diagnostic success and decrease human error?²⁰
- Expert opinion: Daniel Hunt, M.D. (Co-secretary to the Liaison Committee on Medical Education and the Senior Director, Accreditation Services at the Association of American Medical Colleges), when visiting the University of Arizona College of Medicine-Phoenix in 2014 provided the example of the University of Texas-El Paso employing schema-based reasoning in their new medical school. He stated that it was the fourth best innovation in medical education that he had reviewed in the United States, Canada, and England. He strongly recommended schema-based reasoning be considered as the way to proceed in beginners' discussion of clinical cases within medical education curricula at the University of Arizona Medical School-Phoenix.

CAN PHYSICIANS INITIALLY INSTRUCTED IN HYPOTHETICAL – DEDUCTIVE REASONING ADOPT SCHEMA-BASED REASONING?

Evidenced based "research has shown that students respond very favorably to the use of scheme-based problem solving."²¹

In addition, real world experience at the Patan Academy of Health Sciences (PAHS) in Kathmandu, Nepal would say,

"Yes". What follows is support for this opinion.

PAHS follows the British model of graduate medical education. Medical students enter after high school for five and one-half years of study. An individual class is called a 'Batch' and is designated by the year in which the group enters medical school rather than the year of graduation. PAHS admitted its first Batch of fifty-five students in 2010. These students received two years of basic sciences education and analyzed clinical cases in small groups using hypothetical-inductive reasoning. Starting in November 2012, during their third and fourth years, these students transitioned to the use of scheme-based reasoning in accord with the Clinical Presentation (CP) curriculum that had been developed at the University of Calgary Medical School.

In 2011, I was invited to be a member of the international faculty to teach the first Batch students the Pulmonary Block and to assist in the development of the Nepali faculty. I repeated this in 2012 for the second Batch, but with less involvement as the Nepali faculty had markedly improved. In 2013, I was awarded a Fulbright Specialist Grant to assist and to evaluate PAHS in the transition of its first Batch students during their initial clinical rotations from hypothetical-deductive reasoning based to a schema-based reasoning.²² In 2015, I was asked by Banner- University Medical Center Phoenix to establish a bronchoscopy unit at Patan Hospital. While there, I met with eight of the First Batch doctors. They had been awarded their medical degrees at the end of 4 ½ years after cumulative ten-day written and oral examinations. I asked them two questions:

1. How difficult did they find the transition from hypothetical-deductive reasoning to schema-based reasoning?
2. How did they compare themselves with their friends who are graduating from other medical schools in Nepal?

To the first question, they stated that the transition had been quite easy. To the second question, they stated that they felt better trained and more confident than their peers at other medical schools. They then stated that they felt better trained, more confident and better able to diagnose clinical problems than physicians serving in the rural areas who had graduated one or two years earlier from other medical schools.

A month later these young doctors were forced to prove their mettle. On April 24, 2015 a 7.9 earthquake struck the central part of Nepal. It and subsequent landslides

completely destroyed with the loss of all life multiple villages in the Langtang Valley. The major quake and subsequent hundreds of quakes, called "aftershocks," destroyed the central market areas of the three kingdoms of the Kathmandu Valley. Over 9000 persons were killed and 21,000 injured. Patan Hospital converted its outpatient department to evaluate and treat 1500 patients per day. The grassy areas and courtyards were converted to M*A*S*H units. Attending's, house staff and the First Batch students camped out and treated patients 24/7. Within the first few days a contingent of the First Batch students traveled to a district hospital that had been severely damaged was overwhelmed by the first aid and medical needs of the local villagers. The young physicians performed admirably under the most stressful situations.

Photo 1

Dr. Thomson, March 2015 with eight of the First Batch students.



RELEVANCE

For thousands of years expert physicians have passed on to younger generations the qualities needed to become beneficial healers. During this time content knowledge has progressed from fear of evil humors to knowledge of the genetic code. On the other hand, while the technologies used to facilitate learning have markedly evolved, the core methods to encourage critical thinking remain few. Of these methods, two major ones are hypothetical-deductive reasoning and schema-based reasoning. As stated above, both methods equally prepare students for the medical knowledge content portions of the board examinations and encourage critical thinking. But the academic pursuit of critical thinking in the classroom must recognize the real world environment of costs, risks, and limited resources.

This is becoming as true in the United States as it has always been in Nepal. How do these two methods compare using a Strengths, Weaknesses, Opportunities, Threats (SWOT) analysis?

Hypothetical-deductive reasoning's major strength is also its weakness. Its strength is that it encourages beginners to explore multiple possibilities and diagnoses. In the classroom this method is effective and accrues no cost. But its weakness is that is that when applied at the bedside it creates a need to rule out these multiple possibilities and diagnoses by ordering multiple tests with accrued costs and patient risk. In the case of "acute abdomen" presented at the University of Arizona College of Medicine-Phoenix, the Facilitators' Guide lists seventy-five differential diagnoses in alphabetical order for the students to consider and rule out. 23

Schema-based reasoning's strength is that it applies patho-physiologic principles to clinical decision branch points and results in higher diagnostic success. This method of reasoning can be taught to beginners in the classroom, reinforced in the clinical clerkship years, and carried over after graduation to the hospital bedside and clinical practice. The employment of this method increases the odds of achieving diagnostic success. While not yet rigidly analyzed, clinical experience and business acumen would lead one to conclude that achieving a higher probability of diagnostic success with fewer tests, less time, and less risk would result in less cost. Its potential weakness is that it requires expert clinicians to mentor beginners in clinical problem

An Opportunity exists for health care providers to research, teach and to employ schema-based reasoning. In third world countries any decrease in the use of precious resources is critical and welcomed. In the United States with the passage of Affordable Care Act and the advent of Accountable Care Organizations (ACOs) financial risk is being transferred to the providers. Patients will move from being revenue centers to being cost centers (note: recently individual policy holders are being moved from straight Medicare to Medicare Advantage plans, essentially closed panel HMO plans.)

Some savings in patient costs may be achieved by outpatient preventive care. This is a discussion for another day and involves lead time bias. But the vast amount of patient costs will continue to be generated in hospitals. Consequently, those physicians who write most of the orders within hospitals- residents, fellows and hospitalists will need to become more cost efficient, to achieve maximum

productivity with minimum tests, time, risk, and expense. But a weakness is that the majority of these physicians are graduates of medical schools which used a hypothetical-deductive teaching method. This approach to clinical problems remains their primary method during their formative years as they gain clinical experiences and expertise. Herein lies an opportunity for ACOs and other health care providers to evaluate and employ schema-based reasoning in approaching the clinical presentations of their patients.

CONCLUSION:

"Misdiagnoses are among the most common, costly and harmful medical errors. But they are also some of the most preventable." They can never be eliminated totally but the number can be decreased by improving the diagnostic success of physicians both beginners, and experts, like myself, who are asked to see each day living, breathing patients with multiple problems and not just problems attached to a body. Achieving diagnostic success is a core competency for all physicians. How medical students and residents are trained affects how they will practice. Medical schools use various reasoning methods to evaluate clinical cases. All of these methods encourage the pursuit of critical thinking but the use of schema-based reasoning is proving to achieve higher odds of diagnostic success. In the real world environment of patient needs, limited resources, and financial risks this difference may prove to be a selective advantage. The story of PAHS and the lessons learned there may help health care professionals evaluate and introduce schema-based reasoning to improve diagnostic success with the twin goals of maintaining quality medical care while lowering patient care costs.

ABOUT THE AUTHOR:

Brendan D. Thomson M.D., MBA, is Board Certified in Internal Medicine and Pulmonary Diseases and a member of the Society of Critical Care Medicine. In 1995 he was awarded a MBA from Arizona State University West, now the Carey School of Business. Dr. Thomson was in the private practice of pulmonary medicine for twenty-five years prior to becoming the medical director for ten years of a health care company which specialized in the care of geriatric patients. He has been Chief of Staff for two Phoenix area hospitals and is past president of the Samaritan Health Plan. In 1991 he was awarded the Maricopa County Medical Society's Public Service Award. In 2013 he received a Fulbright Specialist Grant to assist the Patan Academy of Health Sciences in Kathmandu, Nepal,

transition from hypothetical-deductive reasoning to schema-based reasoning. In 2015 he was awarded a second Fulbright Specialist Grant to the College of Medicine and Pharmacy in Ho Chi Minh City to assist in their implementing case based instruction. He is an Assistant Professor of Medicine at the University of Arizona College of Medicine-Phoenix and the Medical Director of Hacienda, a not-for-profit facility for developmentally delayed persons. He served on the Board of the Vatican Observatory for fourteen years. He initiated and continues to publish the Official Vatican Observatory Calendar.

For additional information about the views expressed in this article or to answer questions that may arise in implementing a schema-based program in your facility contact Dr. Brendan Thomson M, MBA at bthomson1@cox.net, cell 602 321-557

Photo 2

Dr. Thomson, Kathmandu, March 2015



Some thoughts and wording have been repeated from a previous article published in the Internet Journal of Medical Education.

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