

## **The Computable Patient Record; eMR 5.0 The Next Generation**

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The title of this workshop is based on the definition of the Gartner Fifth Generation electronically enabled medical record (eMR) called the "Mentor"

- *1st: **The Collector** - simple systems that provide a site-specific solution for the need to access clinical data which is imported through scanning or other forms of aggregation*
- *2nd: **The Documenter** - basic systems that clinicians use at the point of care to adequately document rather than merely access clinical data*
- *3rd: **The Helper** - Systems that include episodic and encounter data and use decision support tools to assist clinicians, functional in at the minimum both ambulatory and inpatient settings*
- *4th: **The Partner** - Advanced systems that provide more decision support capabilities and that are operational and accessible across the continuum of care, and providing sufficient credibility as to become the patient's legal medical record*
- *5th: **The Mentor** - Complex and fully integrated systems that include all previous capabilities and that are a main source of decision support in guiding patient care for both clinicians and consumers*

The average eMR in Canada today functions at a level that is stuck between the first and third generations.

Clinicians have unreasonable expectations for their eMRs because the profession has not taken the time and effort to specify what is required of these complex applications and have been offered electric versions of the paper record.

*"The problems of healthcare are rapidly approaching crisis proportions... The application of computer technology offers hope, but... will require a much greater commitment than is presently true of the medical academic community."*

*G. Octo Barnett 1969 (Founder Massachusetts General Hospital Computer Laboratory)*

To be satisfied with our eMRs the clinical information and process content of the medical record must be specified sufficiently to make it computable;

- To get past the document manger EMR and achieve the **"quality and productivity revolutions"** seen elsewhere in society with computer technology we need **machine "computation"** of the medical record

**S:** (n) [calculation](#), **computation**, [computing](#) (the procedure of calculating; determining something by mathematical or logical methods)

### **AND**

We must reinvent the processes of clinical information gathering, storing, processing and retrieval; this is the science of **"Informatics"**

- *"merely automating the form, content and procedures of the current patient records will perpetuate their deficiencies and will be insufficient to meet emerging user needs"*
- *R.S. Dick; E.B. Stein: "The Computer Based Patient Record; An Essential Technology for Health Care"; Institute of Medicine, National Academy of Science 1991*

To achieve this reinvention we must not only study what is;

- *"If communities were the size of cells and if hospitals, pharmacies, laboratories, patients and physicians were the size of sub cellular particles,*
- *no doubt they would be the subjects of a great deal of research, and much more would be known about their relationships and pathophysiology."*  
*Weed, Lawrence; "Medical Records, Medical Education, and Patient Care"; The Press of Case Western Reserve University; 1969*

**BUT ALSO** realize that this healthcare "system" we work in is not a system but a cottage industry devoid of any standards for clinical process or information content.

*National Academy of Sciences*  
**"BUILDING A BETTER DELIVERY SYSTEM  
A New Engineering/Health Care Partnership"**

*Proctor P. Reid, W. Dale Compton, Jerome H. Grossman, and Gary Fanjiang, Editors 2005*

*"provides a framework and action plan for a **systems/informatics** approach to health care delivery based on a partnership between engineers and health care professionals"*

This is the same realization that the NHS has come to after spending 12 billion pounds on eMRs.

*National Health Services Joint WG  
2012*

*"Technical standards alone do not ensure the ability for information systems to transfer interpretable health data around the NHS so that they can be reliably manipulated and understood."*

*"... this problem can be considerably simplified by the clinical professions agreeing on standard clinical representations for the content of medical/healthcare records."*

A 5<sup>th</sup> Generation eMR requires that we create standards for the clinical information and process content of the medical record;

*"Two hundred years ago enlightened physicians understood that empiricism needed to be replaced by a more formal and testable way to characterize disease and its treatment. The tool they used then was the scientific method.*

*Today we are in an analogous situation. Now the demand is that we replace the organizational processes and structures that force the arbitrary selection amongst treatments with ones that can be formalized, tested, and applied rationally."*

*"Four rules for the reinvention of health care"  
Enrico Coiera, BMJ 2004;328:1197-1199 (15 May),*

**THAT** utilize

1) Standard unambiguous medical terminology

- **S:** (n) **terminology, nomenclature, language** (a system of words used to name things in a particular discipline)
- e.g. the "Systematized Nomenclature of Medicine; Clinical Terms" (**SNOMED CT**)

## 2) Clinical Information Models

***What is a Model?***

*"Man tries to make for himself in the way that suits him best a **simplified and intelligible picture of the world** and thus to overcome (sig. understand) the world of experience, for which he tries to some extent to substitute this cosmos (sig. picture) of his. This is what the painter, the poet, the speculative philosopher and the natural scientist do, each in his own fashion... one might suppose that there are any number of possible systems... all with an equal amount to be said for them; and this opinion is no doubt correct, theoretically. But **evolution has shown** that at any given moment out of all conceivable constructions **one has always proved itself absolutely superior to all the rest.**"*

**Einstein, A.** "The World as I See It" (1931)

## 3) and the will to do a better job

- *"If we accept the limits of discipline and form as we keep data in the medical record, the physician's task will be better defined*
  - *...and the art of medicine will gain freedom at the level of interpretation and be released from the constraints that disorder and confusion always impose."*
- Weed, Laurence; 1968*

The choice is ours,

We can turn this;



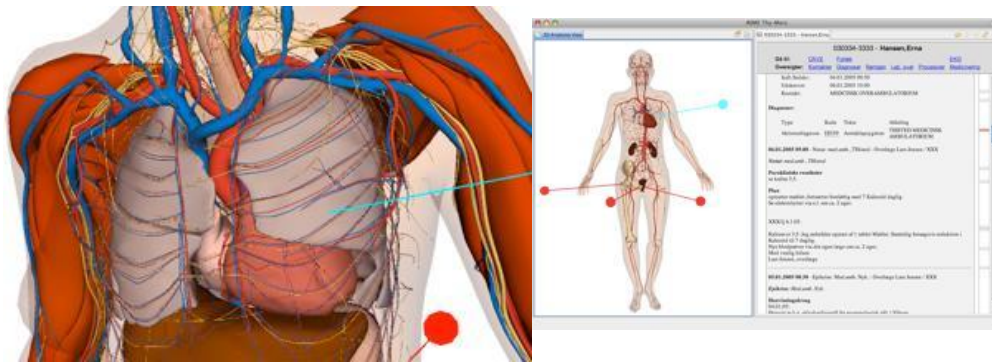
into this;



## Or we can build this

### 3D Patient Avatar for Clinical Information Representation in the Computable Medical Record

- 3D visualization linked to SNOMED terminology



#### ***At the end of this session, participants will be able to:***

- define informatics and its application to achieve safer more effective and efficient clinical practice
- recognize the difference between computable and non computable clinical record content
- articulate the informatics requirements necessary for an eMR to be a computable medical record

#### **Context**

The most common thing a doctor deals with on a daily basis is information.

It has been fifty years since Laurence Weed defined the information requirements necessary for a medical record to be computable; twenty five years since Dick and Stein identified clinical information computability as necessary to achieve improved safety, efficiency and effectiveness in healthcare and fifteen years since Starfield et al decried the lack of information management standards in clinical care and the resultant

morbidity. The failure of electronically enabled medical records to achieve information computability jeopardizes the adoption of eMRs and prevents the improvements in healthcare that should have already been achieved. The science of medical information has been declared a U.S. American Board Certified Medical Specialty. It is a mature science and holds the answer to achieving the computable patient record. This session will introduce the fundamentals of informatics and teach participants how to identify and use informatics in their clinical practice.

**The following are a complete slide set for the workshop. Not all slides will be used.**

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**What is Informatics?**

S: (n) [information science, informatics, information processing, IP](#) (the sciences concerned with gathering, manipulating, storing, retrieving, and classifying recorded information)

<http://wordnetweb.princeton.edu/>

***“A model is ...a simplified and intelligible picture of the world of experience...”***

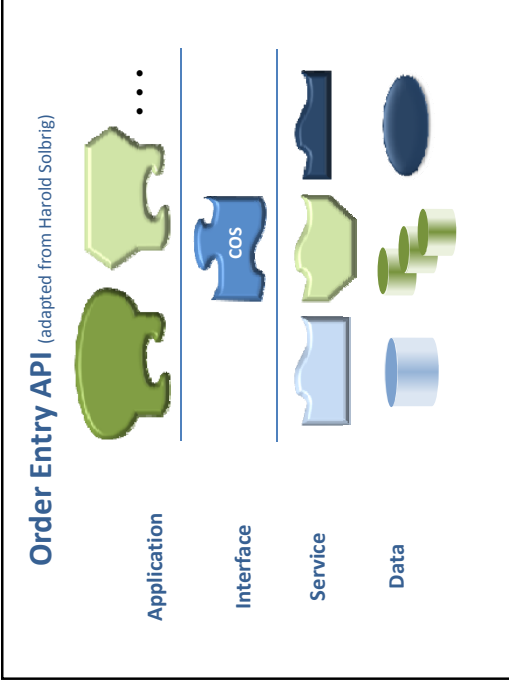
(Albert Einstein 1931)

***“The pivotal concept of informatics is the model.”***

Enrico Coiera; “Guide to Health Informatics”  
1997







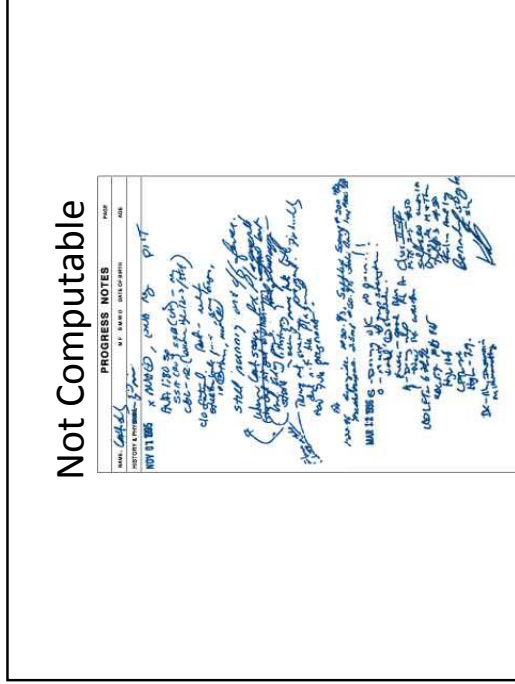
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**The “Computable” Patient Record**

- To get past the document manger EMR and achieve the “**quality and productivity revolutions**” seen elsewhere in society with computer technology we need **machine “computation”** of the medical record

S: (n) [calculation](#), [computation](#), [computing](#) (the procedure of calculating; determining something by mathematical or logical methods)



## Not Computable

→  *Handwritten note:*  
The patient, simple request  
A diagnosis  
We need first in  
Sicut in clembutyl  
expound to la confusio  
a lower price  
Mon. etc. Jansen in, saluabile  
3. 1865  
B.

## Computable

- The standardized nomenclature of medicine

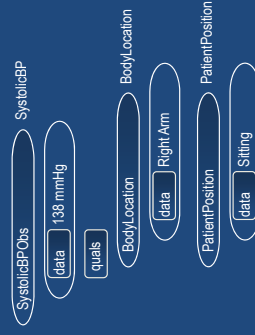
SNOMED

not

ICD 9, 10, 11, or 12

## Computable

### Clinical Information Model for Systolic Blood Pressure



## Semantics anyone?

- ‘‘When I use a word,’’ Humpty Dumpty said in a rather scornful tone, ‘‘it means just what I choose it to mean—neither more nor less.’’
- ‘‘The question is,’’ said Alice, ‘‘whether you can make words mean so many different things.’’
- ‘‘The question is,’’ said Humpty Dumpty, ‘‘which is to be master—that is all.’’
- **‘‘Alice’s Adventures in Wonderland’’**; 1865 Charles Lutwidge Dodgson (aka Lewis Carroll).

## Semantics

- To achieve “machine computation” of the medical record its content must be captured and stored in a **semantic** form that is accessible to the machine.
- This is done by using information models and meta data; e.g. Web 2.0 uses extensible mark up language (XML)
- Medical records use HL7 clinical document architecture (CDA) and openEHR archetypes

## What is a Terminology?

- **S:** (n) **terminology, nomenclature, language** (a system of words used to name things in a particular discipline)
- e.g. the “Systematized Nomenclature of Medicine; Clinical Terms” (SNOMED CT)

- The fundamental motivation for the design and philosophy of the Problem-Oriented Medical Record (POMR) is the belief that the medical record is the central medium of communication and the first repository of knowledge in the practice of clinical medicine.
- “**Medical records, medical education, and patient care: The problem-oriented record as a basic tool;** Weed, Lawrence L. 1970

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## “Data Discipline”

“If we accept the limits of discipline and form as we keep data in the medical record the physician’s task will be better defined ...and the art of medicine will gain freedom at the level of interpretation and be released from the constraints that disorder and confusion always impose.”

Weed, Laurence; 1968

The short falls found can be attributed to three domains:

- a. MONEY: Providers and vendors are reluctant to expense the coding of applications for a small poorly defined market.
- b. STANDARDS: The absence of national standards for the clinical information and process content of the eMR to which vendors and promoters can build with confidence that their investment is safe.
- c. SYSTEMS MODELS: Formal systems models of the Family Medicine teaching center environment, and the healthcare delivery sector in general are required for coding complex integrated software applications.

## National Health Services Joint WG 2012

“Technical standards alone do not ensure the ability for information systems to transfer interpretable health data around the NHS so that they can be reliably manipulated and understood.”

## National Health Services Joint WG 2012

“... this problem can be considerably simplified by the clinical professions agreeing on standard clinical representations for the content of medical/healthcare records.”

## A Vacuum of Leadership

“The problems of *healthcare* are rapidly approaching crisis proportions... The application of computer technology offers hope, but... will require a much greater commitment than is presently true of the medical academic community.”

G. Octo Barnett 1969 (Founder Massachusetts General Hospital Computer Laboratory)

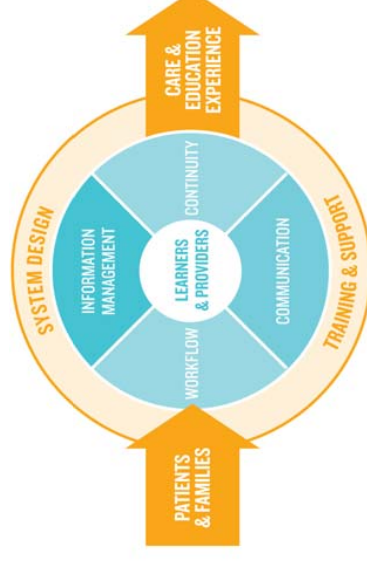
## To achieve the higher level eMR functionality and usability

- The eMR content must be semantically machine computable and hence we need a “computable” eMR.
- Physicians, as the clinical domain experts, must show leadership in the process of defining the clinical content standards for the “computable” eMR.
- The skills needed to define the clinical content and use of “computable” eMRs to the benefit of our patients must be taught to medical students and residents in training if we are to produce sophisticated physician consumers and users of eMRs.

## Computable Medical Records

- Implementation in an academic teaching unit and the effect of sub-optimal systems on data quality

## Framework



**Information Management**

I literally sat there and with the patient playing thesaurus, how many words can there be for kidney or kidney disease...

...[EMR] did not have sulpham, which everybody knows ...the EMR doesn't like it in normal doctor or nurse talk.

We had no way of quickly finding information....they didn't have the right kind of folders.

**Workflow: Clinical Processes**

And if the person comes in, and they're on a dozen meds and they say, "I need them all refilled today,"

I warn them ahead of time now and say, this is going to take 15 minutes.....

I'll ask them specifically about their parking, where are you parked and how much time do you have

**Workflow: Scope and Workarounds**

...learning how to [not] get onto a slippery slope with clinicians doing work that could be done by someone else....

I would just find some kind of a workaround that I could get that patient out the door without pulling my hair out

**Workflow: Time**

You're spending probably 5 to 7 minutes finding the form.

[Inputting] family history literally now can take 20 to 25 minutes because each family member with each of their medical problems, has to be entered individually.

## Workflow: Teaching

you could sit in a different room and view the chart as the patient is being seen.

...we are talking to the patient, not to the computer.

Our teaching has probably been hampered; we're so preoccupied with trying to get through the day.

Does the data being entered into the EMR database accurately represent what we think it should?



## Completeness- BP Record vs. Billing (Hypertension)



	A	B	C	D	E	F	WRHA Average
BP Record Completeness Indicator- Hypertension (%)	81.22%	72.89%	93.23%	48.09%	56.37%	94.92%	74.45%

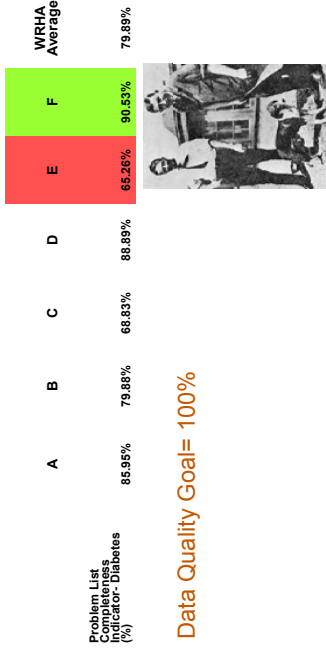
Data Quality Goal= 100%

## Consistency of Capture – Social Determinants of Health

	A	B	C	D	E	F	WRHA Average
Alcohol Use	25.66%	25.01%	21.77%	2.34%	21.65%	44.02%	23.41%
Tobacco Use	31.47%	29.46%	30.27%	9.45%	39.39%	63.65%	33.95%
Employment	20.70%	21.74%	11.58%	5.66%	15.66%	42.46%	19.63%
Housing	5.40%	4.45%	6.04%	3.58%	21.15%	46.24%	14.48%



## Completeness - Diabetes vs. Insulin/PO Hypoglycemic (excluding metformin)



## Electronic Paper Records

- If systems we implement merely replicate paper process we lose the true power of a computable medical record
- This data shows we have a long way to go in terms of achieving such a goal
- The current state requires high degree of data cleaning and abstraction to achieve meaningful information (ie CPCSSN)
- Larry Weed quote ??

## Basic Requirements of a Computer-based Patient Record

- Easy data entry
- Data that can be exchanged with other users without the need for manual data re-entry.
- The ability to use clinical decision support with rules that are imported and these rules will work because data is standardized

## Emerging Trends

- With interoperable EHR systems and integrated decision support and care planning tools, clinicians will be better able to coordinate the best possible patient care across all parts of the organization.
  - A physician may have to review 200 new documents a day
- **Population health management:** There is a great drive toward identifying at-risk or future-risk populations. This is done by using data to identify high-risk patients and whole patient populations. Doing so will require fully integrated EHRs and tools to facilitate care plan development, identify patient risk and measure performance.
- **Chronic care management:** EHRs equipped with integrated clinical decision support and chronic care management tools will help physicians manage information and monitor the outcomes of patients with chronic conditions like COPD, CHF or diabetes, according to a [report](#) from the Agency for Healthcare Quality and Research (AHRQ).
- **Personalized medicine:** The evolution of personalized medicine requires healthcare to overcome the barriers of interoperability, standards, data sharing, privacy and predictive modeling. The goal is to use data to identify individual patients and whole patient populations. Doing so will become more efficient, effective, and truly personalized.”
  - <https://www.clinicalkey.com/info/blog/ehrs-going-widely-implemented-widely-helpful/>

## Lindberg

- Practitioners of medicine needs the help of computer techniques
- for the storage and retrieval of facts of care of their individual patients
- in order to place these facts immediately in the spectrum of similar studies are observations on other patients in the same hospital or region
- in order to keep contact with the every growing mass of new medical knowledge 1968

## The message is clear

- EHRs should perform tasks and functions for physicians, rather than burdening them with extra, time-consuming work unless it directly affects care delivery.
- EHRs should help physicians view patient information more quickly and efficiently. And they should support – not interfere with – physician documentation of patient stories and sound, accurate evidence-based decision making.
- <https://www.clinicalkey.com/info/blog/ehrs-going-widely-implemented-widely-helpful/>

## EHR weaknesses - workflow interruptions and interoperability

- Clinical workflow interruptions and interoperability are two of the most significant weaknesses within EHRs, say 59 percent of survey respondents, while 12.6 percent cite system expense as a major roadblock to EHR implementation and use.
- EHRs disrupt clinical workflow because they're unable to mirror or capture the ways physicians work, according to a majority of survey respondents. Physicians are under pressure to capture an ever-increasing stack of information on every patient, knowing that only a portion of that information relates to a diagnostic or treatment decision.
- <https://www.clinicalkey.com/info/blog/ehrs-going-widely-implemented-widely-helpful/>

## EHR vendors may have lost sight of clinical needs

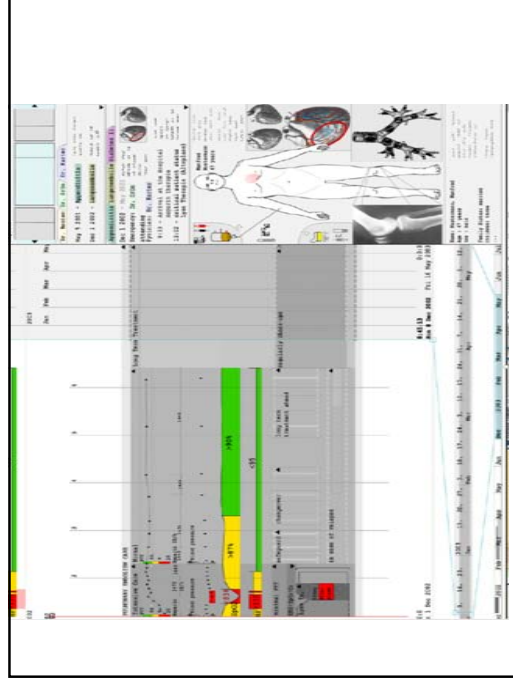
- Many physicians believe that EHR vendors may have lost sight of clinical needs for workflow functionality and interoperability, according to a 2014 survey of 150 providers [reported](#) in *Health IT Outcomes*.
- Faced with an overwhelming imperative to complete MU certification, EHRs are “teaching to the test.” “EHR manufacturers have become so focused on ensuring their software is MU-certified that many have lost sight of the functionality that is truly important to health providers,” says *Health IT Outcomes* editor-in-chief Ken Congdon.
- <https://www.clinicalkey.com/info/blog/ehrs-going-widely-implemented-widely-helpful/>

## Physician dissatisfaction with EHRs is rampant

- Many offer feedback on the burdens of computerized documentation, including data entry and poor workflow support. Such usage issues often translate into reduced time for clinical care, data analysis and evidence-based decision-making, according to a 2013 [report](#) from RAND and the American Hospital Association (AHA).
- Physicians' complaints range from data entry, usability, inefficiency, and less time for patient care, to limited data exchange between EHRs and erosion of clinical documentation.
- <https://www.clinicalkey.com/info/blog/ehrs-going-widely-implemented-widely-helpful/>

## Medical terms

- Medical students spend a lot of effort in learning medical terminology so they can communicate with other clinicians
- It is important to know where the pectinate line is as opposed to the olecranon
- It is also important to know which fundus someone is talking about
- fracture one or more fingers of hand
- inflammatory disease of cervix, vagina, and vulva
- blindness and low vision
- Malignant neoplasm of trachea bronchus and lung
- Occlusion and stenosis of precerebral arteries
- Aortic aneurysm and dissection
- Thyrotoxicosis with or without goiter
- What impression do these leave with the reader?

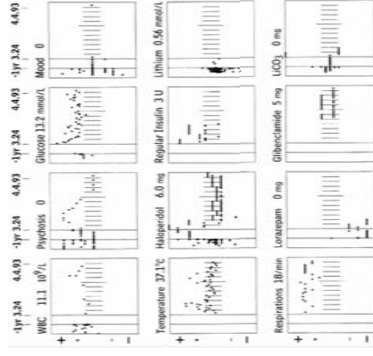


## What is needed to get these displays

- Consistency in data entry
- Ability to aggregate different concepts to higher level concepts
- Try to import data and minimize manual data entry



## Normalization - Powsner & Tuft 1994



## Situational Awareness

- Patient with Ebola not diagnosed because travel history was buried in nursing notes
- The problem was not only with the computer application but with the configuration but also with the humans that did not ask the obvious question

## Preattentive Attributes

How many fives do you find in each rectangle below?



- When prescribing ramipril – display the most recent potassium level and the eGFR
- When looking at diabetes in the problem list – display the most recent A1c

## Cognitive Load

- The effects of cognitive load are underappreciated by EMR vendors
- The capacity of working memory is very limited
- Should avoid forcing users to make decisions based on what was displayed on a previous screen
- Each click represents a decision, physicians complain about too many clicks