Health IT in Clinical Settings

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For Ramathibodi M.S. & Ph.D. Programs in Data Science for Healthcare & Clinical Informatics

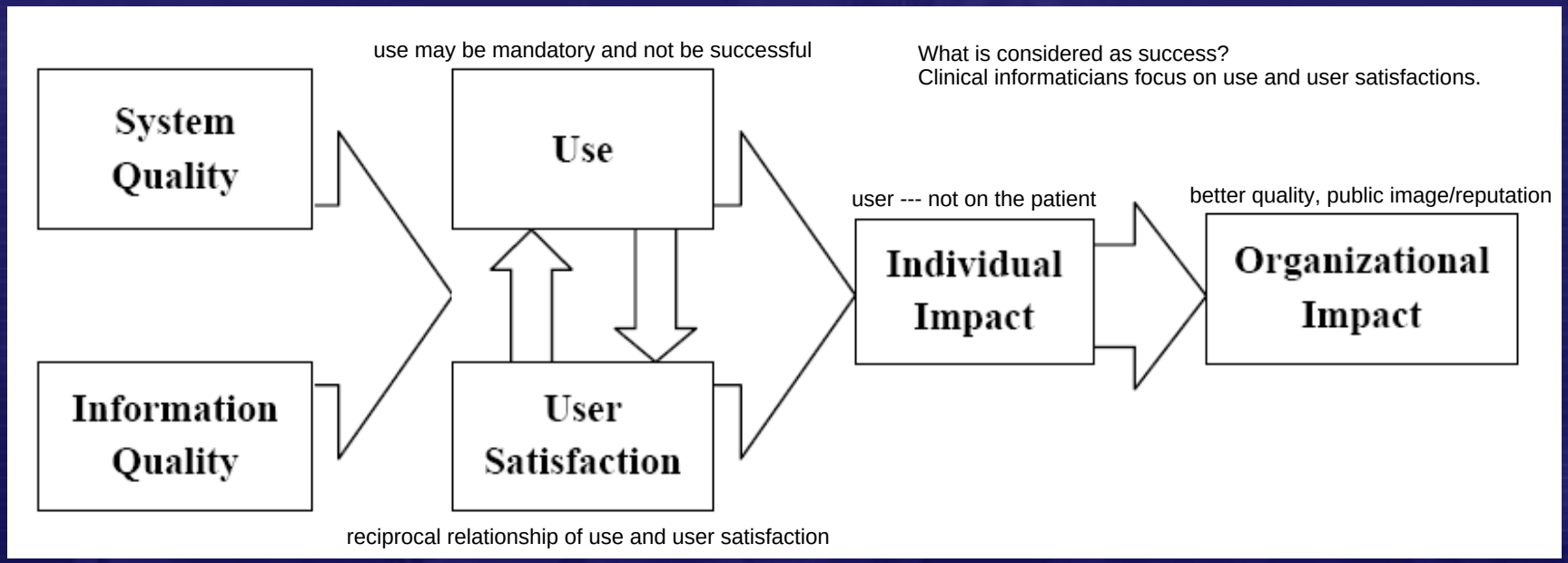
October 20, 2022 SlideShare.net/Nawanan

IT Decision Making in Hospitals: Key Points

- Depends on local context
- IT is not alone -> Business-IT alignment/integration
- “Know your organization”
- View IT as a tool for something else, not the end goal by itself
- Focus on the real goals (what define “success”)

Success of IT Implementation

DeLone & McLean (1992)



Success of IT Implementation

System Quality

- System performance (response time, reliability)
- Accuracy, error rate
- Flexibility
- Ease of use
- Accessibility

Success of IT Implementation

Information Quality

- Accuracy
- Currency, timeliness
- Reliability
- Completeness
- Relevance
- Usefulness

Success of IT Implementation

Use

- Subjective (e.g. asks a user “How often do you use the system?”)
- Objective (e.g. number of orders done electronically)

User Satisfaction

- Satisfaction toward system/information
- Satisfaction toward use

Success of IT Implementation

Individual Impacts

- Efficiency/productivity of the user
- Quality of clinical operations/decision-making

Organizational Impacts

- Faster operations, cost & time savings
- Better quality of care, better aggregate outcomes
- Reputation, increased market share
- Increased service volume or patient retention

NOW, WHAT ARE SOME IMPORTANT HOSPITAL IT?

Examples of Hospital IT

Enterprise-wide

- Infrastructural IT (e.g. hardware, OS, network, web, e-mail)
- Office Automation
- MPI, ADT Master Patient Index
- EHRs/EMRs/HIS/CIS
- CPOE & CDSSs
- Nursing applications
- Billing, Claims & Reimbursements Financial Management Information Systems
- MIS, ERP, CRM, DW, BI Customer Relationship Management, Data Warehouse

Examples of Hospital IT

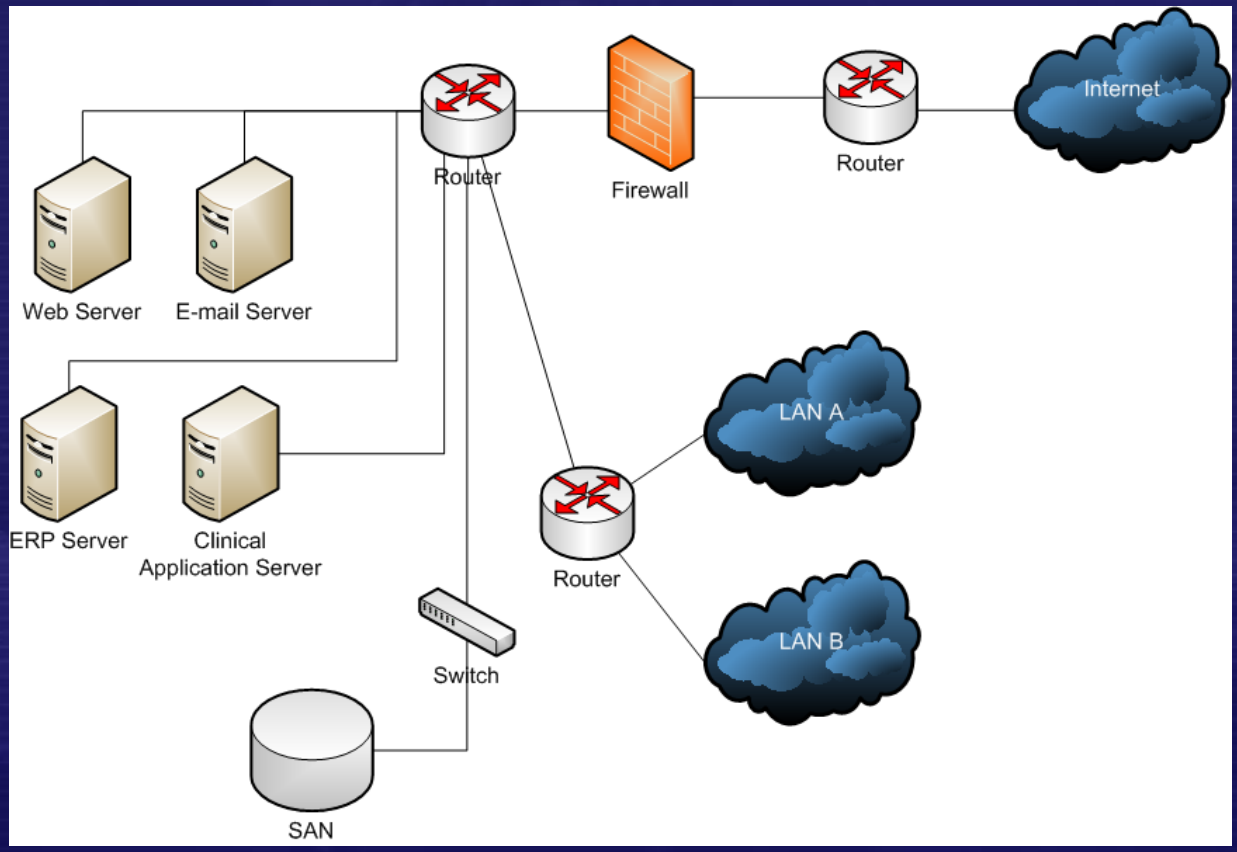
Departmental Applications

- Pharmacy applications
- LIS, PACS, RIS Laboratory Information System, Picture Archiving and Communication System
- Specialized applications (ER, OR, LR, Anesthesia, Critical Care, Dietary Services, Blood Bank)
- Incident management & reporting system
- E-Learning
- Clinical research informatics

The IT Infrastructure

Infrastructural IT

- HW/SW Acquisition, installation & maintenance
- System administration
- Network administration
- Security



Infrastructural IT

Issues

- Expertise
- Insourcing vs. Outsourcing
- Policy & Process Controls
- Best Practices in Design & Management
- Documentation!!!
- Risks
  - Confidentiality/Integrity
  - Outages
  - Redundancy vs. Cost
  - Configuration complexities & patch management
  - Compatibility & Technology Choices

The Clinical IT

Master Patient Index (MPI)

- A hospital's list of all patients
- **Functions**
  - Registration/identification of patients (HN/MRN)
  - Captures/updates patient demographics
  - Used in virtually all other hospital service applications
- **Issues**
  - A large database
  - Interface with other systems
  - Duplicate resolutions
  - Accuracy & currency of patient information
  - Language issues

Know Your Customer (KYC) process is helpful and reliable but not entirely used in medical settings, especially for emergency situations.
- Sending photo with ID attached, other forms of verification process

Language issues
- For example: Middle name? Philippines uses middle initial instead
- Thai and English names

PAC Systems use English names

Admission-Discharge-Transfer (ADT)

- **Functions**
  - Supports Admission, Discharge & Transfer of patients ("patient management")
  - Provides status/location of admitted patients
  - Used in assessing bed occupancy
  - Linked to billing, claims & reimbursements
- **Issues**

How can you ensure that the location is accurate?

  - Accuracy & currency of patient status/location
  - Handling of exceptions (e.g. patient overflows, escaped patients, home leaves, discharged but not yet departed, missing discharge information)
  - Input of important information (diagnoses, D/C summary)
  - Links between OPD, IPD, ER & OR

EHRs & HIS

EHR: Patient's overall health record from various healthcare providers
EMR: Patient's digital version of a paper chart from one provider only. Hence cannot be shared with another healthcare provider

The Challenge - Knowing What It Means

EHR is a subset of HIS/CIS
EHR system = CIS (Western countries)
Support other functions?

since health is broader than medical EHR is used since it can be used to other healthcare providers
organized chronologically

Electronic Health Records (EHRs)

EHR: designed to support medical decisions

broader IS than CIS

Hospital Information System (HIS)

used for diagnosis and treatment only

Electronic Medical Records (EMRs)

Only used in UK

Electronic Patient Records (EPRs)

focuses on clinical services

Clinical Information System (CIS)

Computer-Based Patient Records (CPRs)

Personal Health Records (PHRs)

PHR: consumer-patient oriented, the patient has accessed to their own records
Only the key information is provided. Tether: connected PHR to EHR, it depends if hospitals allow to extend the PHR

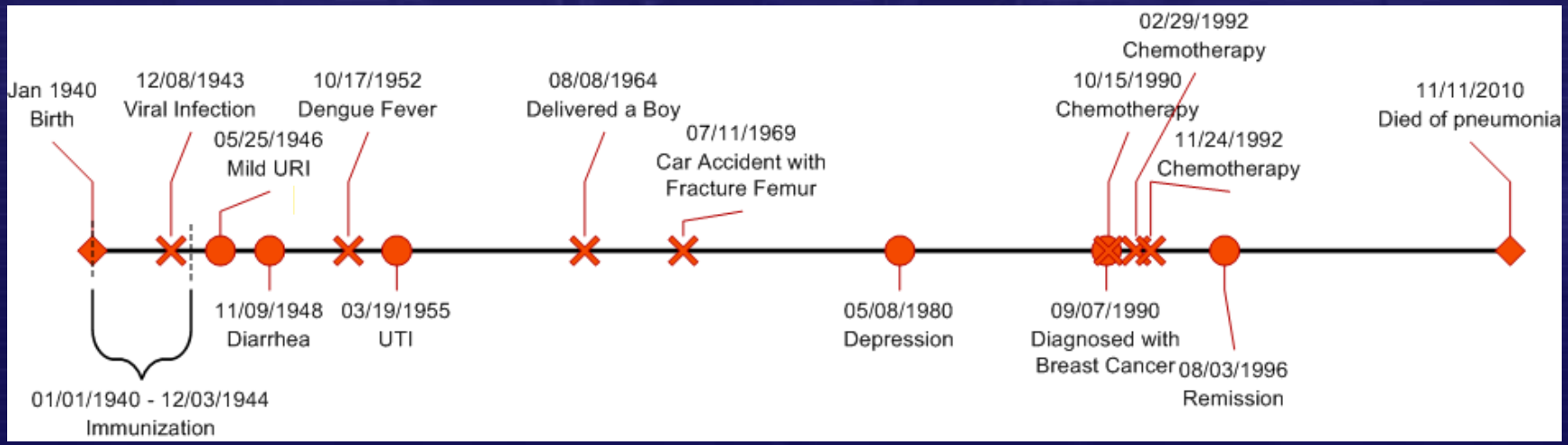
EHR System = CIS?

EHRs

One patient can have several episodes but with one encounter (visit). Various episodes and encounters utilize longitudinal record system.

Commonly Accepted Definitions

- Electronic documentation of patient care by providers
- Provider has direct control of information in EHRs
- Synonymous with EMRs, EPRs, CPRs
- Sometimes defined as a patient's longitudinal records over several "episodes of care" & "encounters" (visits)



EHR Systems

Are they just a system that allows electronic documentation of clinical care?

EHR system = document record electronically?

Or do they have other values?

Documented Benefits of Health IT

- Literature suggests improvement through
  - Guideline adherence (Shiffman et al, 1999;Chaudhry et al, 2006)
  - Better documentation (Shiffman et al, 1999)
  - Practitioner decision making or process of care (Balas et al, 1996;Kaushal et al, 2003;Garg et al, 2005)
  - Medication safety (Kaushal et al, 2003;Chaudhry et al, 2006;van Rosse et al, 2009)
  - Patient surveillance & monitoring (Chaudhry et al, 2006)
  - Patient education/reminder (Balas et al, 1996)
  - Cost savings and better financial performance (Parente & Dunbar, 2001;Chaudhry et al, 2006;Amarasingham et al, 2009; Borzekowski, 2009)

Functions that Should Be Part of EHR Systems

- Computerized Medication Order Entry (IOM, 2003; Blumenthal et al, 2006)
- Computerized Laboratory Order Entry (IOM, 2003)
- Computerized Laboratory Results (IOM, 2003)
- Physician Notes (IOM, 2003)
- Patient Demographics (Blumenthal et al, 2006)
- Problem Lists (Blumenthal et al, 2006)
- Medication Lists (Blumenthal et al, 2006) Philippine National Drug Formulary
- Discharge Summaries (Blumenthal et al, 2006)
- Diagnostic Test Results (Blumenthal et al, 2006)
- Radiologic Reports (Blumenthal et al, 2006)

EHR Systems/HIS: Issues

- Functionality & workflow considerations
- Structure & format of data entry
  - Free text vs structured data forms
  - Usability
  - Use of standards & vocabularies (e.g. ICD-10, SNOMED CT)
  - Templates (e.g. standard narratives, order sets)
  - Level of customization per hospital, specialty, location, group, clinician
  - Reduced clinical value due to over-documentation (e.g. medico-legal, HA)
  - Special documents (e.g. operative notes, anesthetic notes)
  - Integration with paper systems (e.g. scanned MRs, legal documents)
- Reliability & contingency/business continuity planning
- Roll-out strategies & change management
- Interfaces

Computerized (Physician/Provider) Order Entry

Functions

- Physician directly enters medication/lab/diagnostic/imaging orders online
- Nurse & pharmacy process orders accordingly
- Maybe considered part of an EHR/HIS system

Computerized Provider Order Entry (CPOE)

Values

- No handwriting!!!
- Structured data entry: Completeness, clarity, fewer mistakes (?)
- No transcription errors!
- Streamlines workflow, increases efficiency

Computerized (Physician/Provider) Order Entry

Issues

- "Physician as a clerk" frustration
- Usability -> Reduced physician productivity?
- Unclear value proposition for physician?
- Complexity of medication data structure
- Integration of medication, lab, diagnostic, imaging &other orders
- Roll-out strategies & change management

Cedars-Sinai Doctors Cling to Pen and Paper Washington Post (March 21, 2005)

"One of the most important lessons learned to date is that the complexity of human change management may be easily underestimated"

Langberg ML (2003) in "Challenges to implementing CPOE: a case study of a work in progress at Cedars-Sinai"

Nursing Applications

Functions

- Documents nursing assessments, interventions & outcomes
- Facilitates charting & vital sign recording
- Utilizes standards in nursing informatics
- Populates and documents care-planning
- Risk/incident management
- etc.

Issues

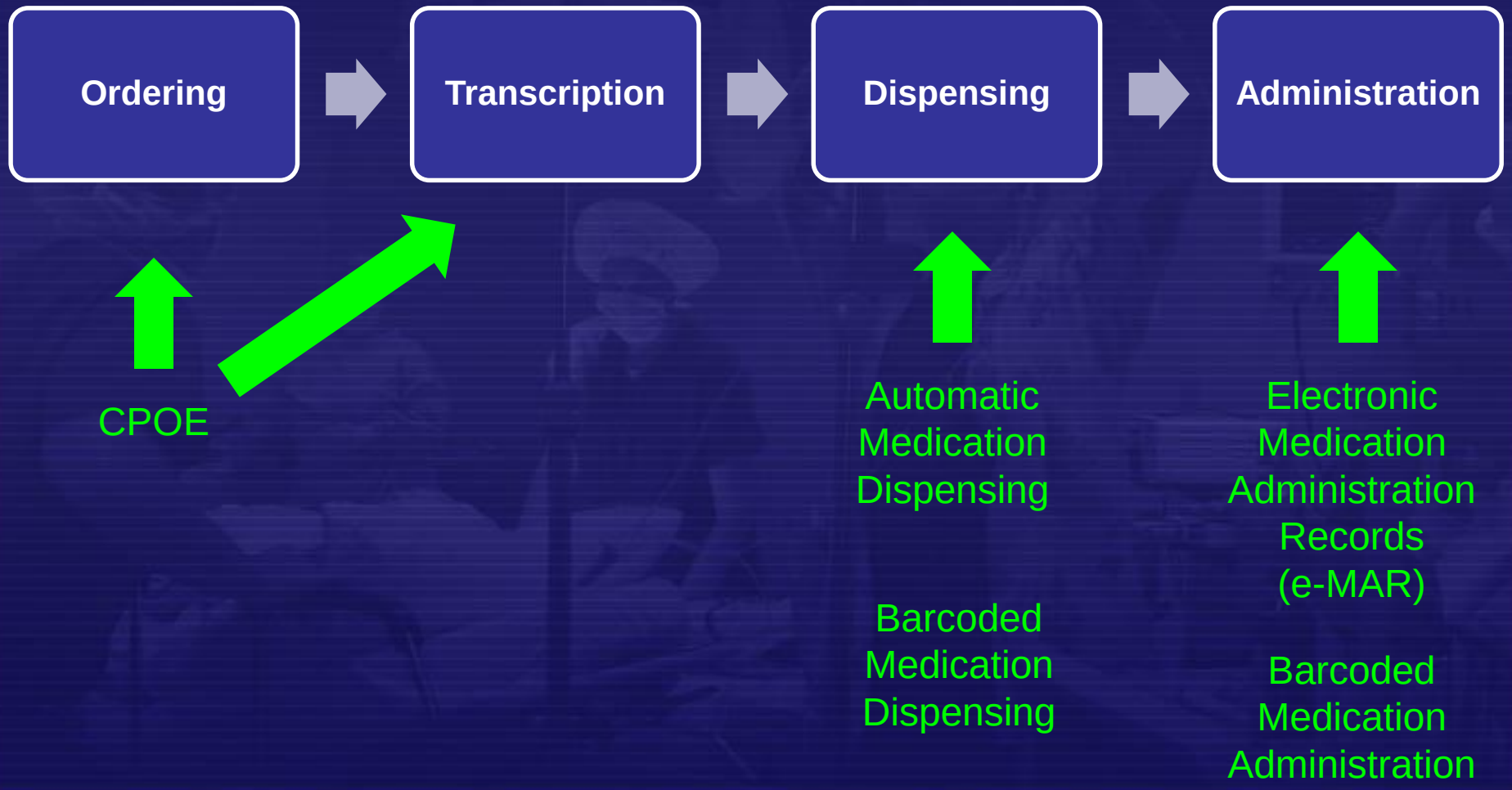
- Minimizing workflow/productivity impacts
- Goal: Better documentation vs. better care?
- Evolving standards in nursing practice
- Change management

Pharmacy Applications

Functions

- Streamlines workflow from medication orders to dispensing and billing
- Reduces medication errors, improves medication safety
- Improves inventory management

Stages of Medication Process & Closed Loop Medication Management



Pharmacy Applications

Issues

- Who enters medication orders into electronic format at which stage?
- Unintended consequences
- “Power shifts”
- Handling exceptions (e.g. countersigns, verbal orders, emergencies, formulary replacements, drug shortages)
- Choosing the right technology for the hospital
- Goal: Workflow facilitation vs. medication safety?

Imaging Applications

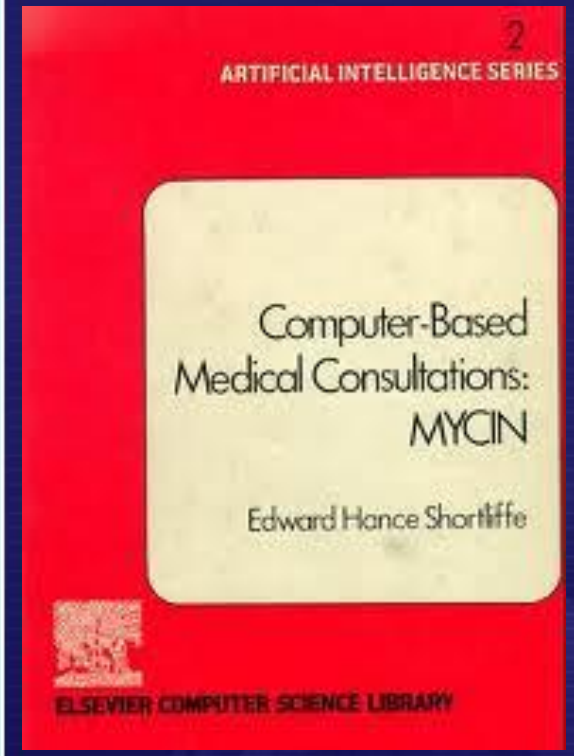
Picture Archiving and Communication System (PACS)

- Captures, archives, and displays electronic images captured from imaging modalities (DICOM format)
- Often refers to radiologic images but sometimes used in other settings as well (e.g. cardiology, endoscopy, pathology, ophthalmology)
- Values: reduces space, costs of films, loss of films, parallel viewing, remote access, image processing & manipulation, referrals

Radiology Information System (RIS) or Workflow Management

- Supports workflow of the radiology department, including patient registration, appointments & scheduling, consultations, imaging reports, etc.

Clinical Decision Support Systems (CDS)



(Shortliffe, 1976)

- The real place where most of the values of health IT can be achieved
  - **Expert systems**
    - Based on artificial intelligence, machine learning, rules, or statistics
    - Examples: differential diagnoses, treatment options

Clinical Decision Support Systems (CDS)

- Alerts & reminders
  - Based on specified logical conditions
  - Examples:
    - Drug-allergy checks
    - Drug-drug interaction checks
    - Reminders for preventive services
    - Clinical practice guideline integration

Example of “Reminders”

More CDS Examples

- Reference information or evidence-based knowledge sources
  - Drug reference databases
  - Textbooks & journals
  - Online literature (e.g. PubMed)
  - Tools that help users easily access references (e.g. Infobuttons)

Infobuttons

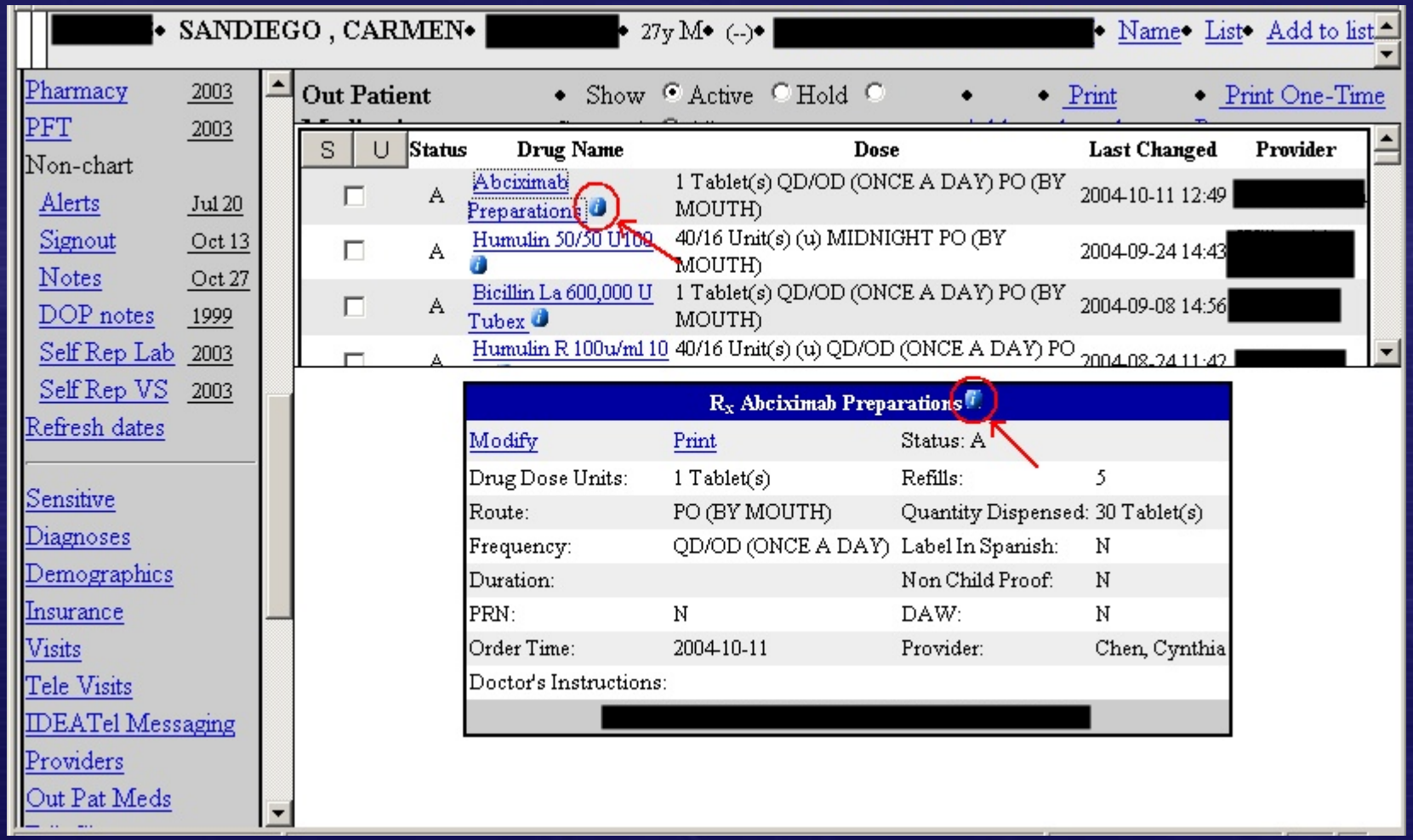


Image Source: https://webcis.nyp.org/webcisdocs/what-are-infobuttons.html

Other CDS Examples

- Pre-defined documents
  - Order sets, personalized “favorites”
  - Templates for clinical notes
  - Checklists
  - Forms
- Can be either computer-based or paper-based

Order Sets

Check boxes as applicable

PREOP WORKUP:

1. ☐ EKG if 50 yrs old or greater or if 40-50 yrs old with known cardiac disease, hypertension, diabetes, or renal disease, or with history indicative of these.
   Note: No EKG if patient has had another EKG within 6 months with no change in physical status or history (copy on chart)
2. ☒ Nasal culture for MRSA and Staph aureus
3. ☒ CBC with differential
4. ☒ Basic metabolic panel, prealbumin, transferrin
5. ☒ PT/PTT
6. ☐ Sed rate, C-reactive protein (high sensitivity) for joint revision
7. ☒ Clean catch urinalysis and urine C&S
8. ☒ Preoperative Joint Class and discharge planning
9. ☒ Give patient surgical scrub solution and instruct on use
10. ☒ Initiate Clinical Pathway Guidelines ☐ Total knee arthroplasty ☐ Total hip arthroplasty
11. ☒ Instruct patient to discontinue all NSAIDs and aspirin 7 days prior to surgery date

DAY OF SURGERY:

12. Type and cross morning of surgery
    - ☐ Total hip – 2 units blood
    - ☐ Total knee – 2 units blood
    - ☐ Hip revision – 3 units blood
    - ☐ Knee revision – 2 units blood

Image Source: http://www.hospitalmedicine.org/ResourceRoomRedesign/CSSSIS/html/06Reliable/SSI/Order.cfm

Other CDS Examples

- Simple UI designed to help clinical decision making
  - Abnormal lab highlights
  - Graphs/visualizations for lab results
  - Filters & sorting functions

Abnormal Lab Highlights

Profile | Problems | **Results** | Reports | Notes | Medications | Order

All Recent | Blood | Urine | Microbiology | Single Result | Blood Bank | CSF

Last Day | Last Week | Last 30 Days | All Results | ☐ Expand Display | From Date 10/22/06

Blood

Hematology

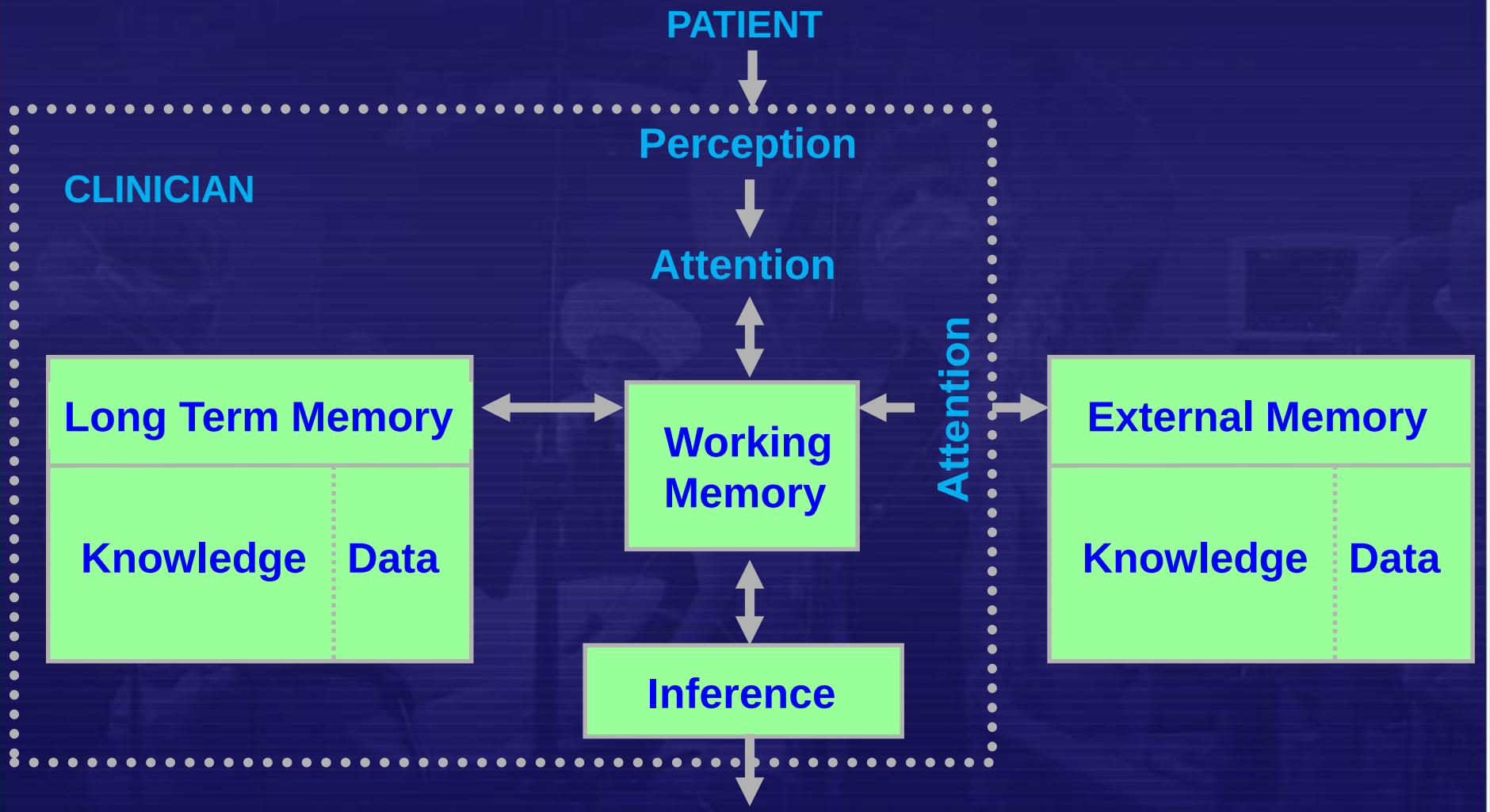
COMPLETE BLOOD COUNT	WBC	RBC	Hgb	Hct	MCV	MCH	MCHC	RDW	Plt Ct
09 Apr 2008 11:25AM	10.8	4.0*	12.9*	36*	88	34*	34	15.9*	288
09 Apr 2008 11:25AM	10.0	4.0*	12.9*	36*	88	34*	34	15.9*	208

DIFFERENTIAL	Neuts	Bands	Lymphs	Monos	Eos	Baso	Atyps	Metas	Myelos	Promyc
09 Apr 2008 11:25AM	55	1	2*	20*	20*	1	0	0	1*	
09 Apr 2008 11:25AM	44*	3	25	18*	6*	2	0	2*	0	

RED CELL MORPHOLOGY	Hypochr	Anisocy	Poiklo	Macrocy	Microcy	Polychr	Spheroc	Ovalocy	Target	Sickle
04 Apr 2008 11:24AM	NORMAL	1+	NORMAL	NORMAL	1+	NORMAL				
04 Apr 2008 11:07AM	NORMAL[1]	1+	NORMAL	NORMAL	1+	NORMAL				

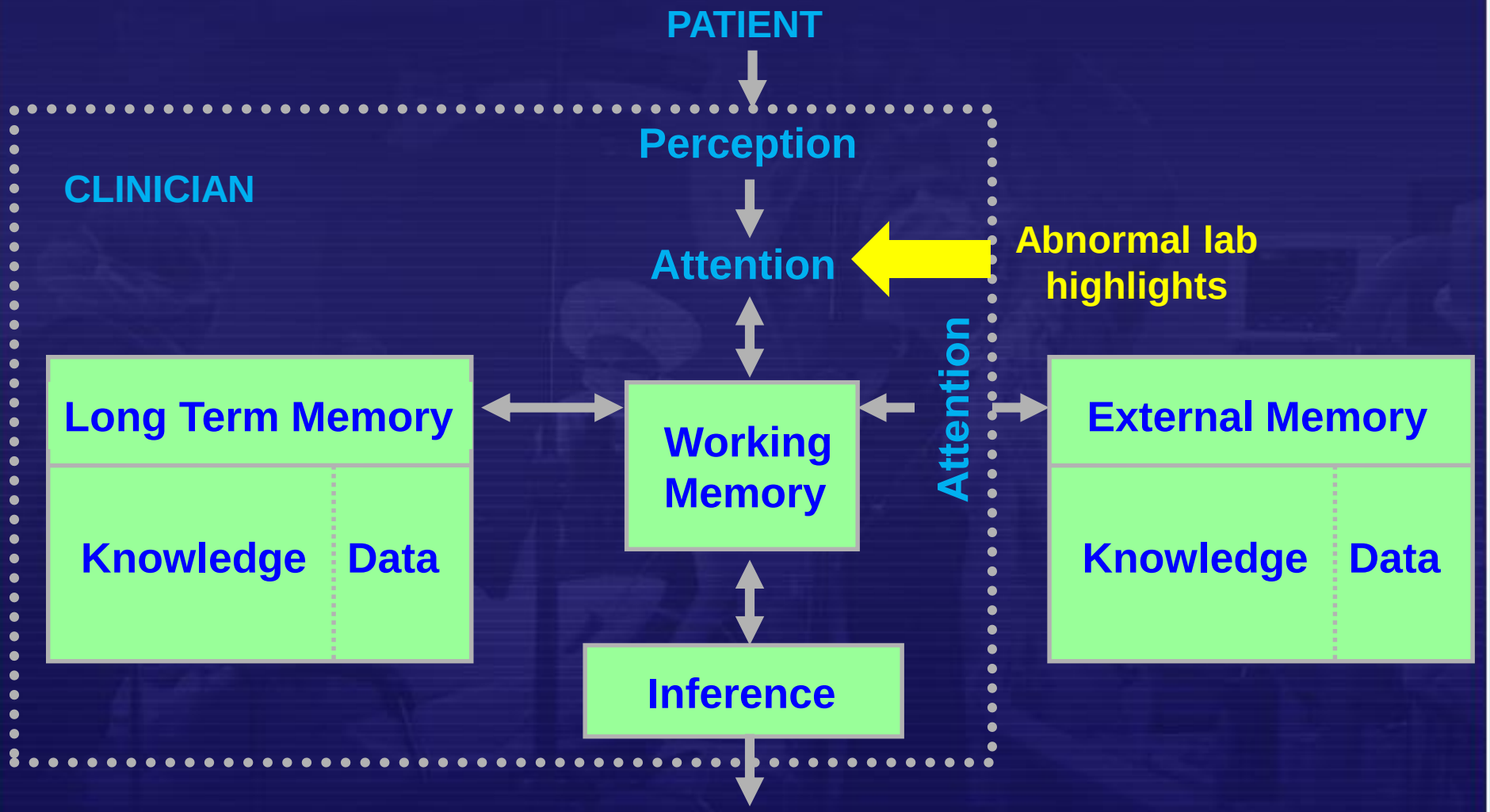
Image Source: http://geekdoctor.blogspot.com/2008/04/designing-ideal-electronic-health.html

Clinical Decision Making



Elson, Faughnan & Connelly (1997)

Clinical Decision Making



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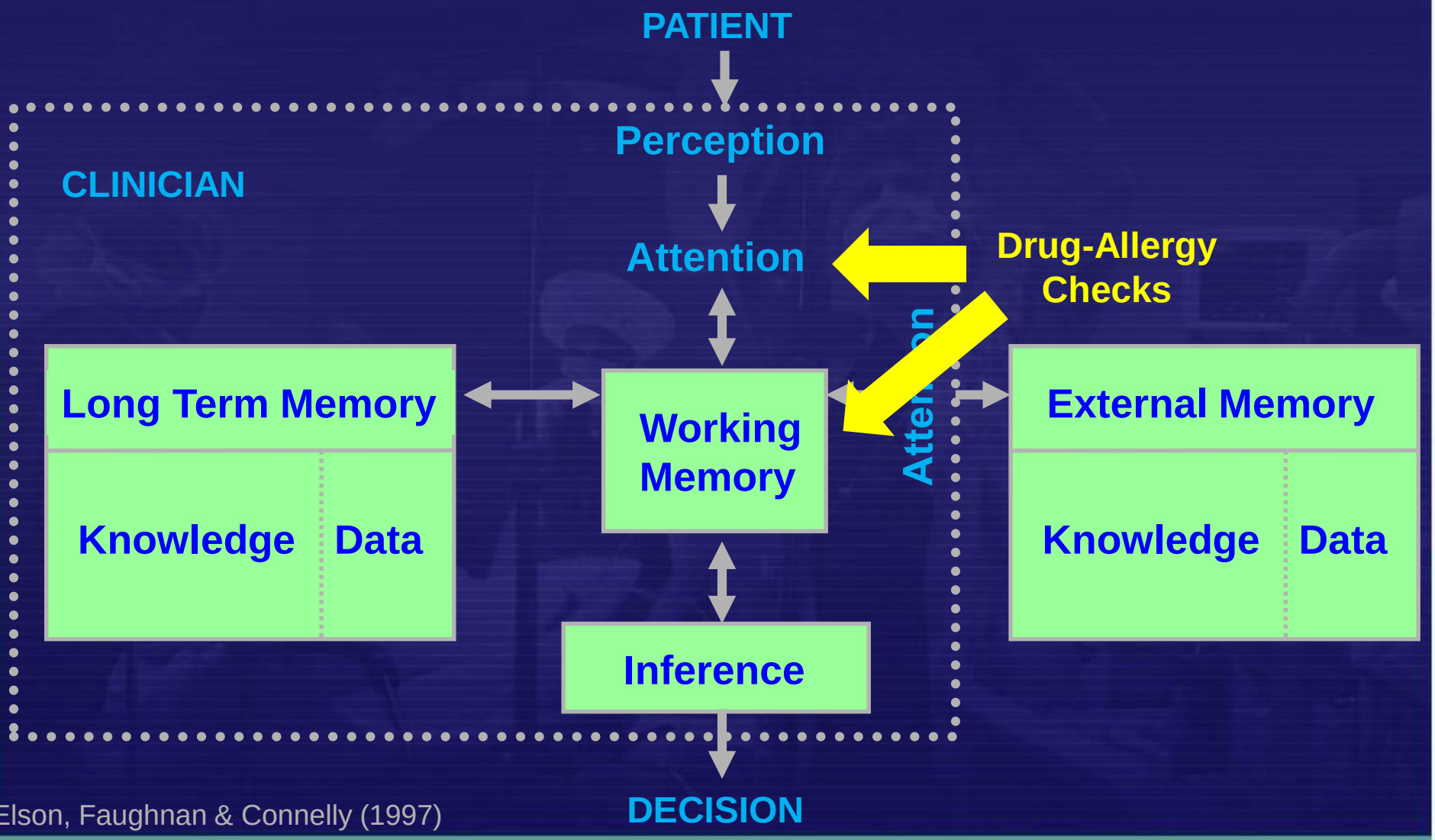
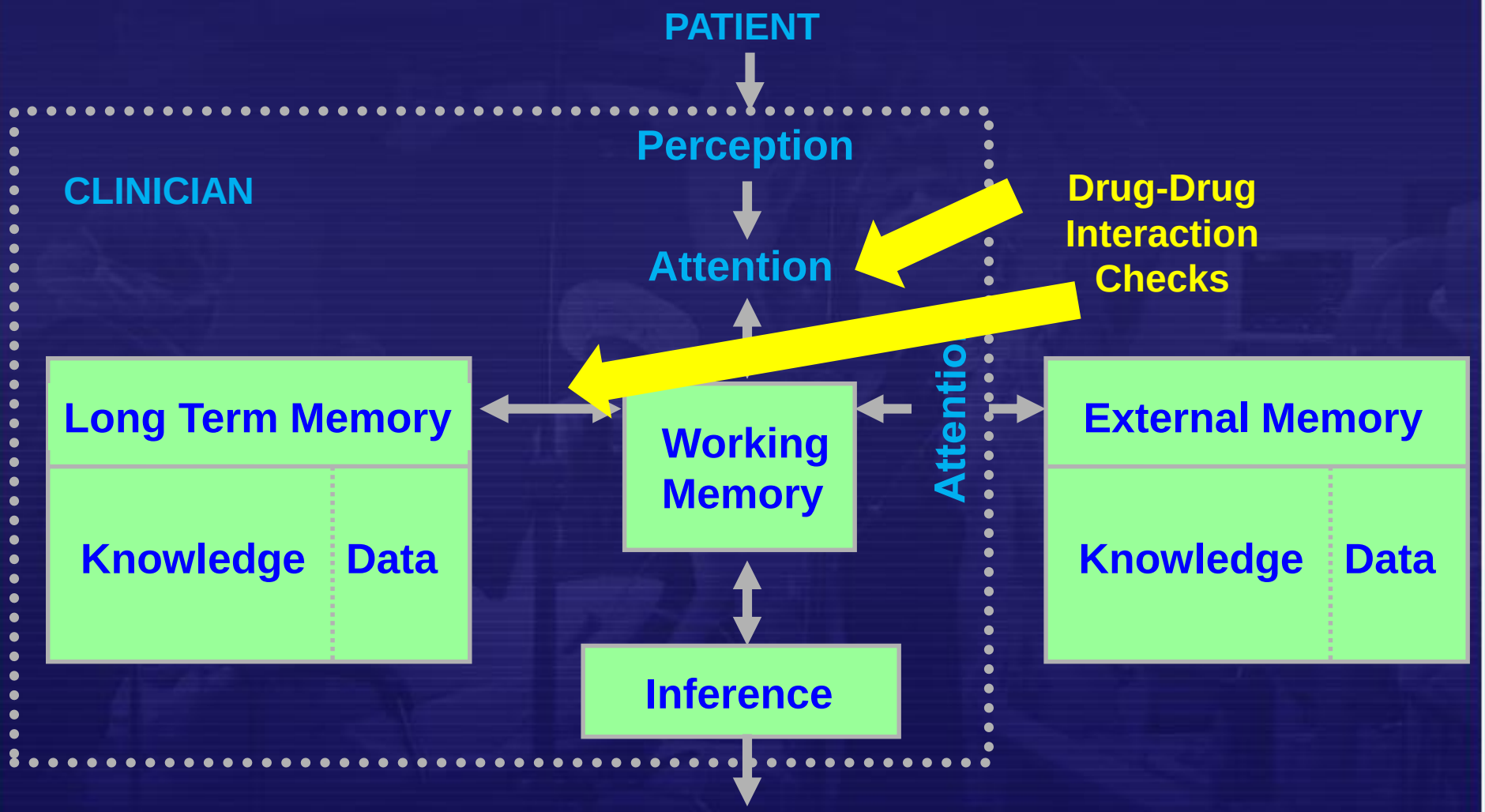
Clinical Decision Making



Elson, Faughnan & Connelly (1997)

Clinical Decision Making



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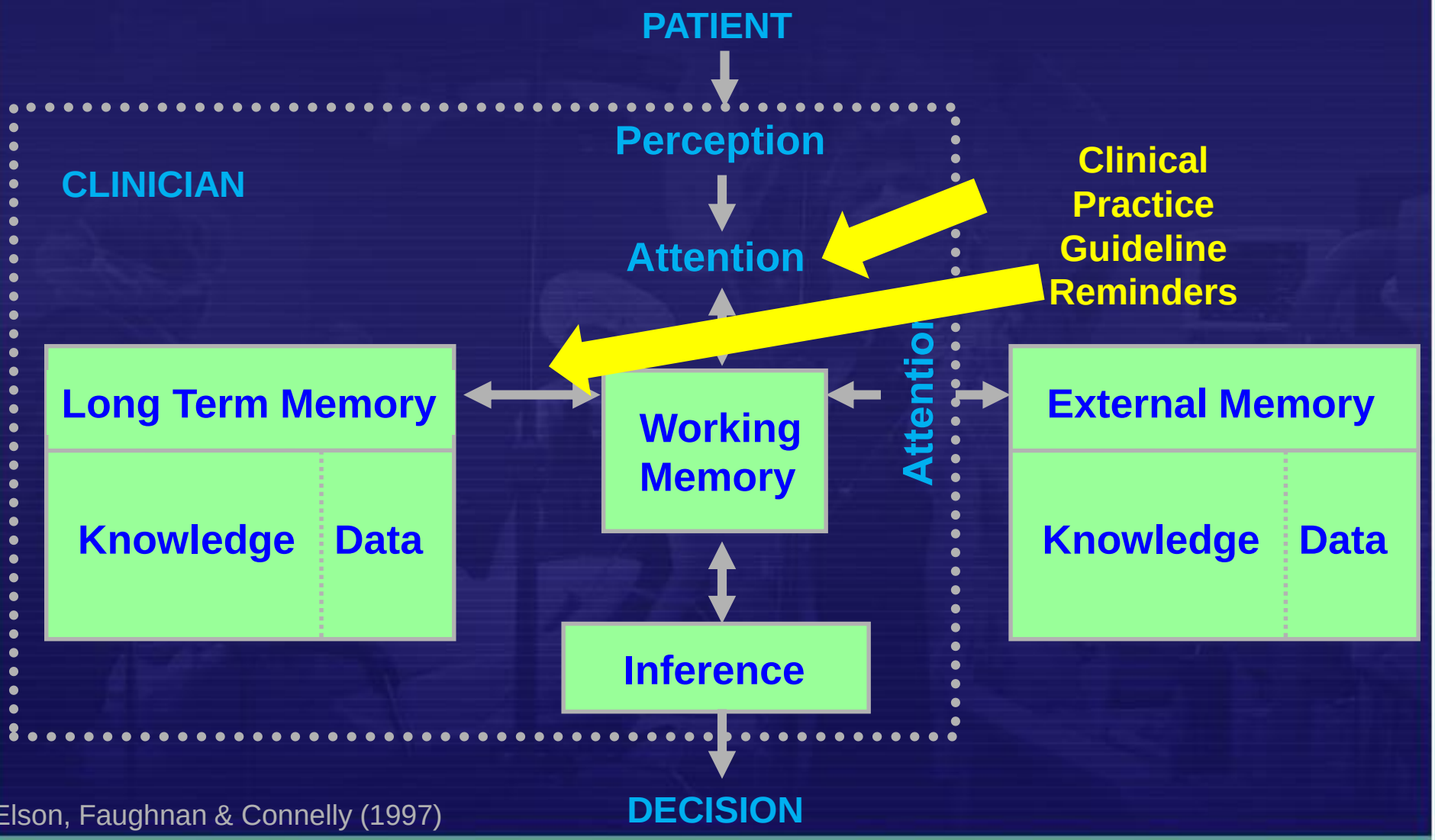

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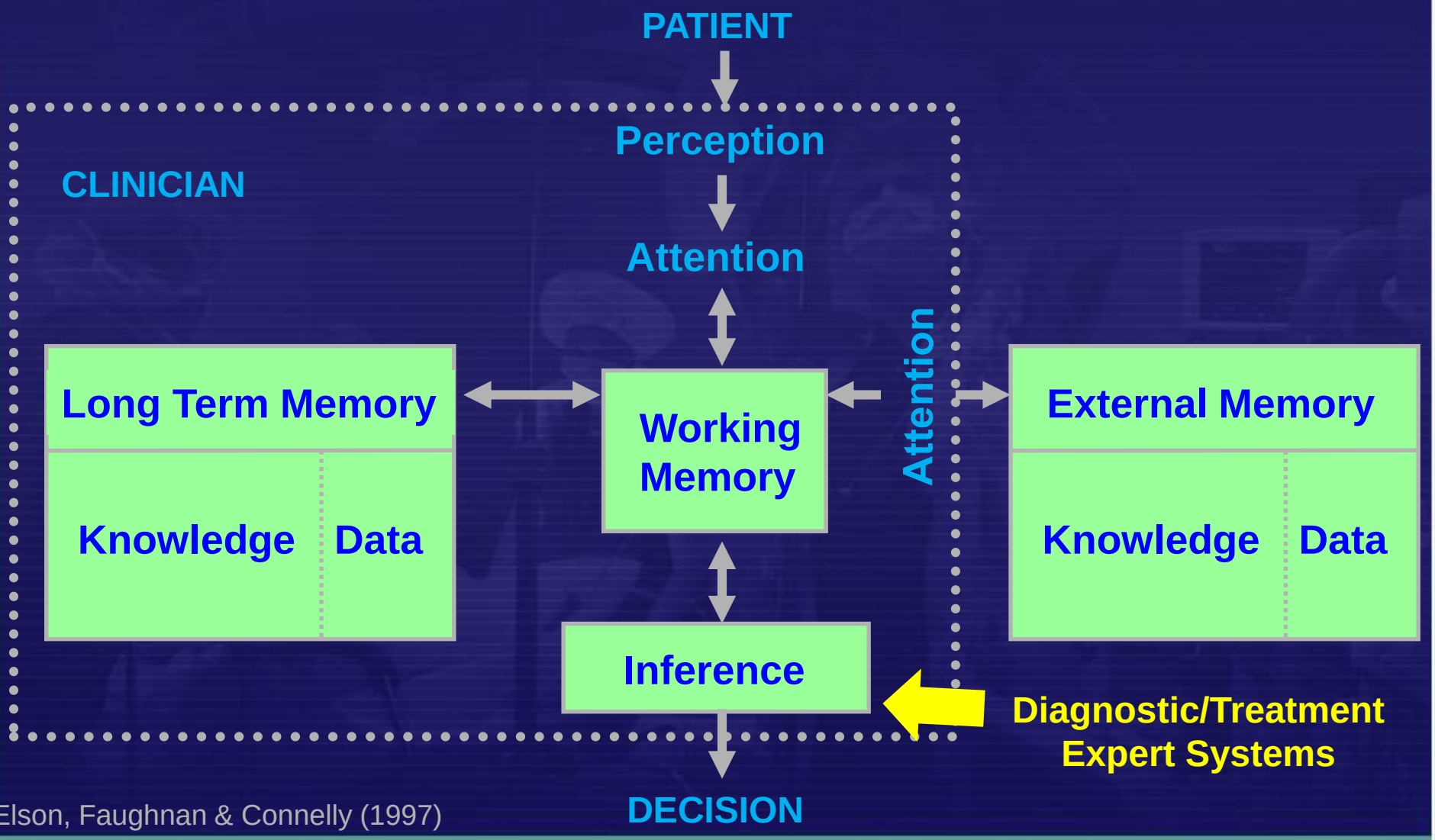
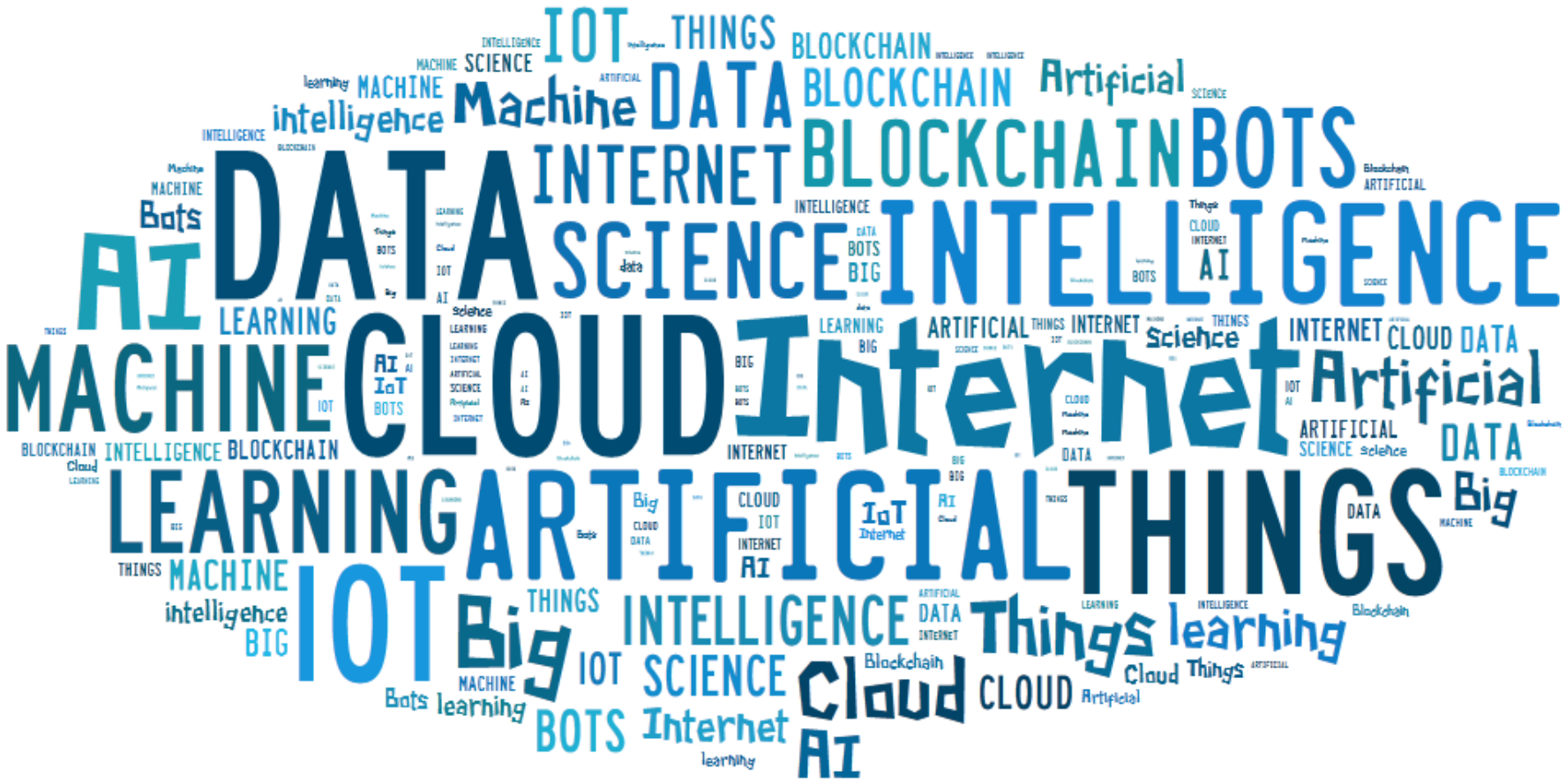


Elson, Faughnan & Connelly (1997)

What words come to mind when you hear...

Digital Health Transformation



https://medium.com/@marwantarek/it-is-the-perfect-storm-ai-cloud-bots-iot-etc-4b7cbb0481bc

An Era of Smart Machines

Google DeepMind's 'AlphaGo' Program Defeats Human Go Champion For The First Time Ever

BY **AVANEESH PANDEY** ON 01/28/16 AT 5:50 AM

Google DeepMind

IBM Watson

http://www.ibtimes.com/google-deepminds-alphago-program-defeats-human-go-champion-first-time-ever-2283700
http://deepmind.com/ http://socialmediab2b.com

Rise of the Machines?

Image Source: englishmoviez.com

Digitizing Healthcare

Image Source: http://www.bloomberg.com/bw/stories/2005-03-27/cover-image-the-digital-hospital

Smart Phones, Dumb People?

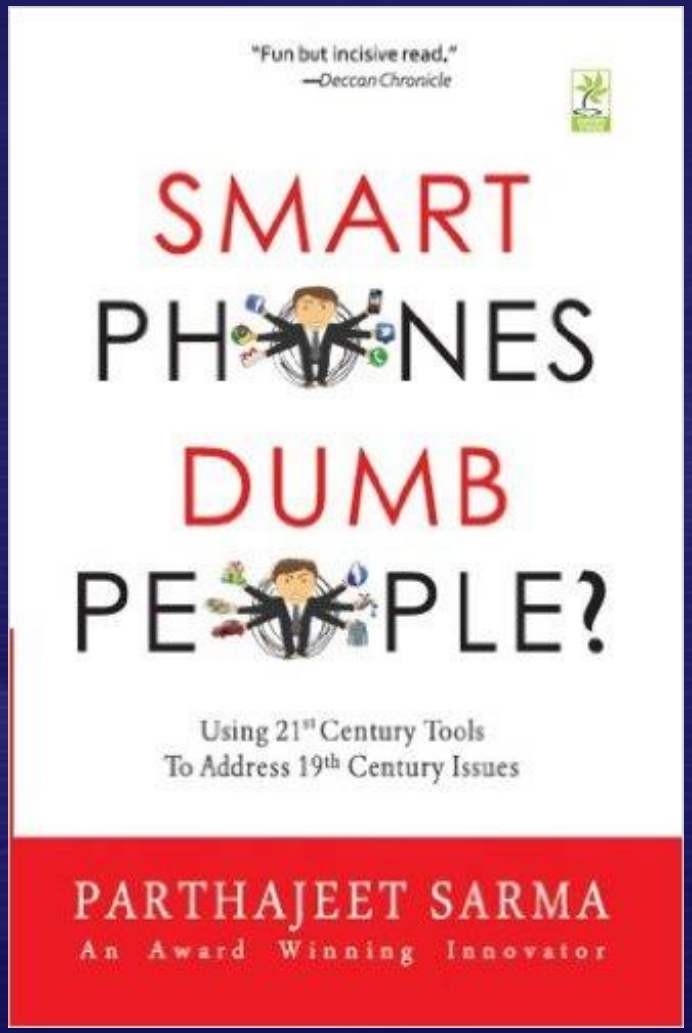


Image Source: amazon.com

Smart Hospital, Dumb Doctors?

“Teenage Sex” of IT

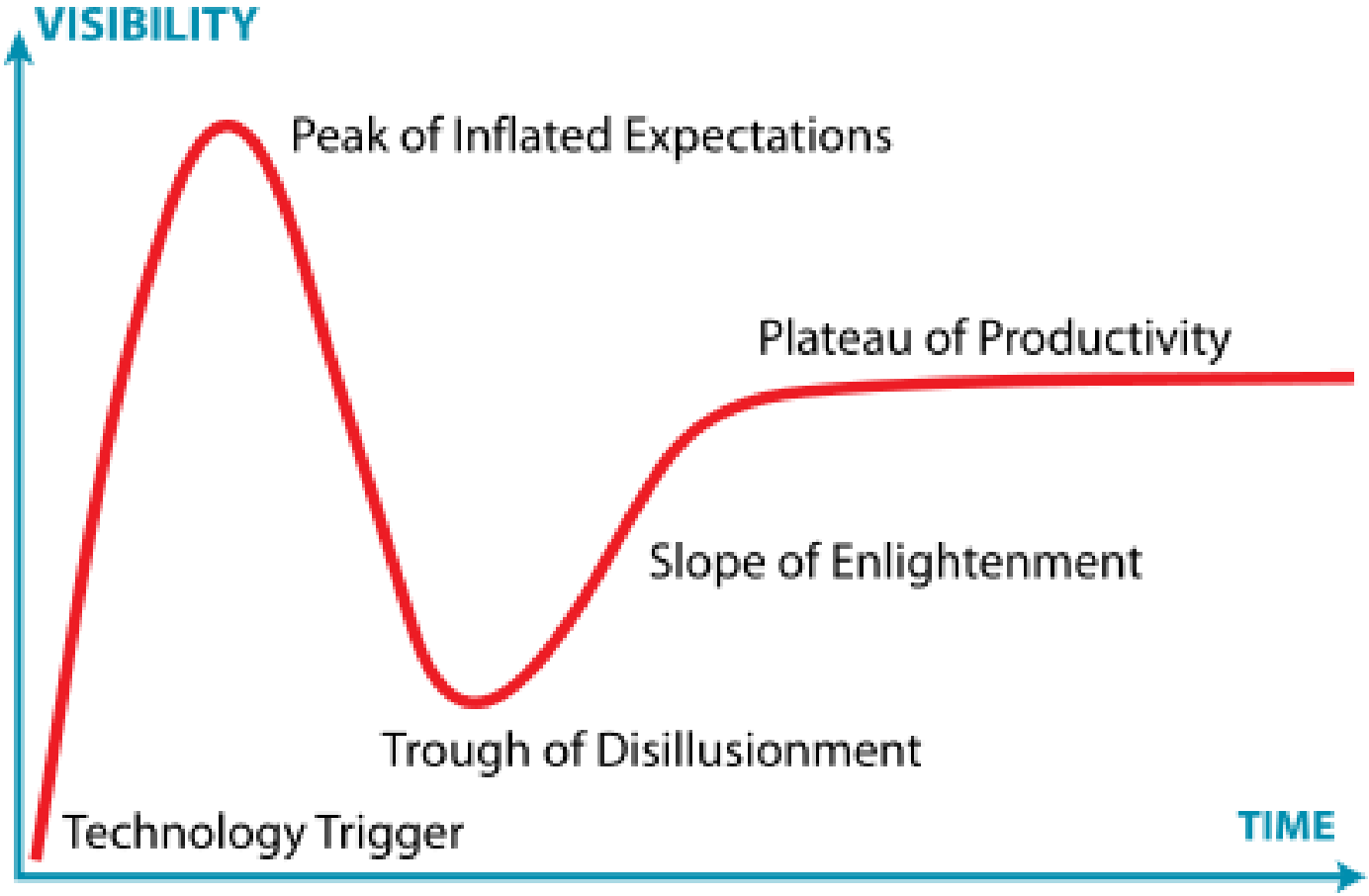
“Big data is like teenage sex:
everyone talks about it,
nobody really knows how to do it,
everyone thinks everyone else is doing it,
so everyone claims they are doing it...”

-- Dan Ariely @danariely (2013)

Substitute “Big data” with “AI”, “Blockchain”, “IoT” of your choice.

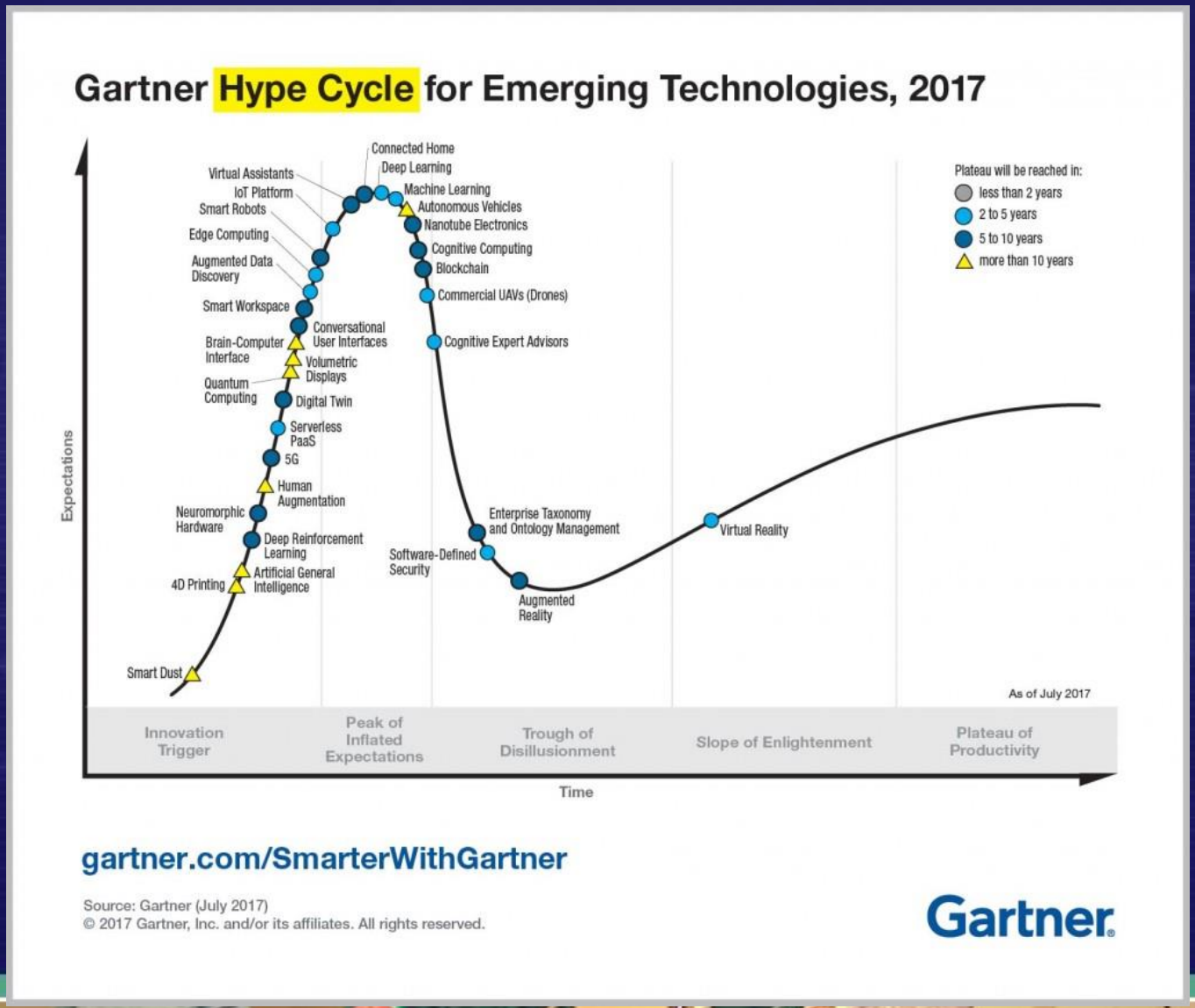
-- Nawanan Theera-Ampornpunt (2018)

Hype vs. Hope



Jeremy Kemp via http://en.wikipedia.org/wiki/Hype_cycle
http://www.gartner.com/technology/research/methodologies/hype-cycle.jsp

Gartner Hype Cycle 2017



https://www.gartner.com/smarterwithgartner/top-trends-in-the-gartner-hype-cycle-for-emerging-technologies-2017/

“Smart” Machines?

Ethiopian Airlines crash investigators reach 'conclusion' using black box data

Mirror 29th Mar 2019 11:20:47 GMT +0300

https://www.standardmedia.co.ke/article/2001318679/ethiopian-airlines-crash-investigators-reach-conclusion

https://www.bbc.com/news/business-47514289

A Real-Life Personal Story of My Failure (as a Doctor and as a Son) in Misdiagnosing My Mom

Would AI Help?

Why Clinical Judgment Is Still Necessary?

- Nothing is certain in medicine & health care
- Large variations exist in patient presentations, clinical course, underlying genetic codes, patient & provider behaviors, biological responses & social contexts

Why Clinical Judgment Is Still Necessary?

- Most diseases are not diagnosed by diagnostic criteria, but by patterns of clinical presentation and perceived likelihood of different diseases given available information (differential diagnoses)
- Human is good at pattern recognition, while machine is good at logic & computations

Why Clinical Judgment Is Still Necessary?

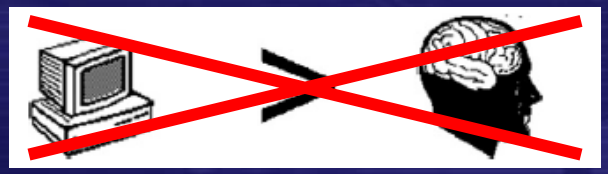
- Machines are (at best) as good as the input data
  - Not everything can be digitized or digitally acquired
  - Not everything digitized is accurate (“Garbage In, Garbage Out”)
- Experience, context & human touch matters

Proper Roles of CDS

- CDSS as a replacement or supplement of clinicians?
  - The demise of the "Greek Oracle" model (Miller & Masarie, 1990)

The "Greek Oracle" Model

Wrong Assumption



The "Fundamental Theorem" Model

Correct Assumption

Digitization ≠ Digital Transformation

Being Smart #1:

Stop Your "Drooling Reflex"!!

Being Smart #2:

Focus on Information & Process Improvement, Not Technology

“Smart Hospital”

Why Aren't We Talk About These Words?

http://hcca-act.blogspot.com/2011/07/reflections-on-patient-centred-care.html

The Goal of Health Care

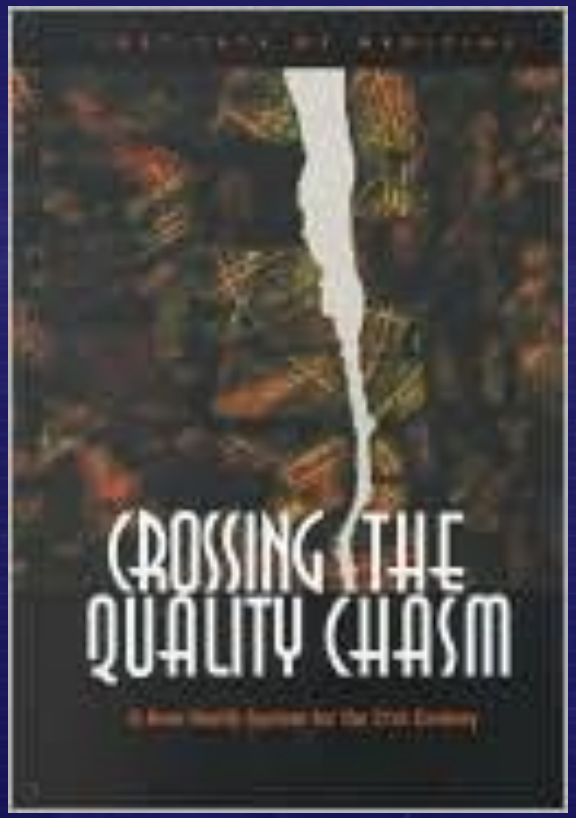
The answer is already obvious...

“Health”

“Care”

High Quality Care

- Safe
- Timely
- Effective
- Patient-Centered
- Efficient
- Equitable



Institute of Medicine, Committee on Quality of Health Care in America. Crossing the quality chasm: a new health system for the 21st century. Washington, DC: National Academy Press; 2001. 337 p.

Health IT

Health ⟵ Goal

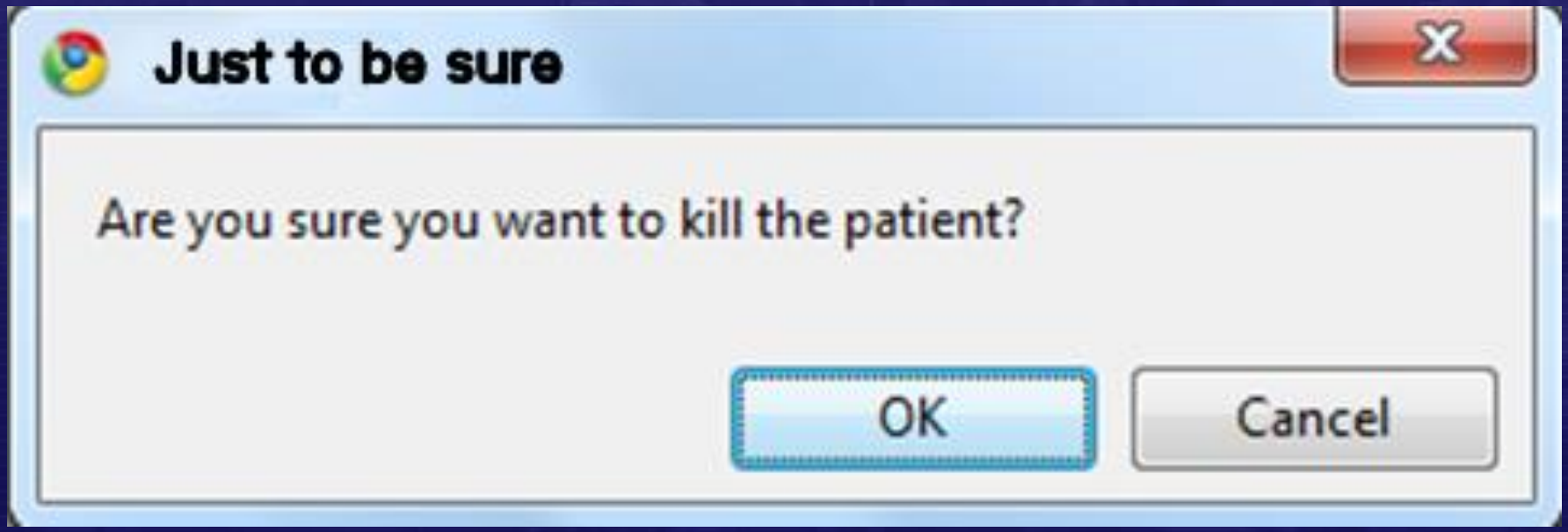
Information ⟵ Value-Add

Technology ⟵ Means/Tools

Unintended Consequences of Health IT

Some risks

- Alert fatigue



Workarounds

Clinical Decision Support Systems (CDSSs)

Issues

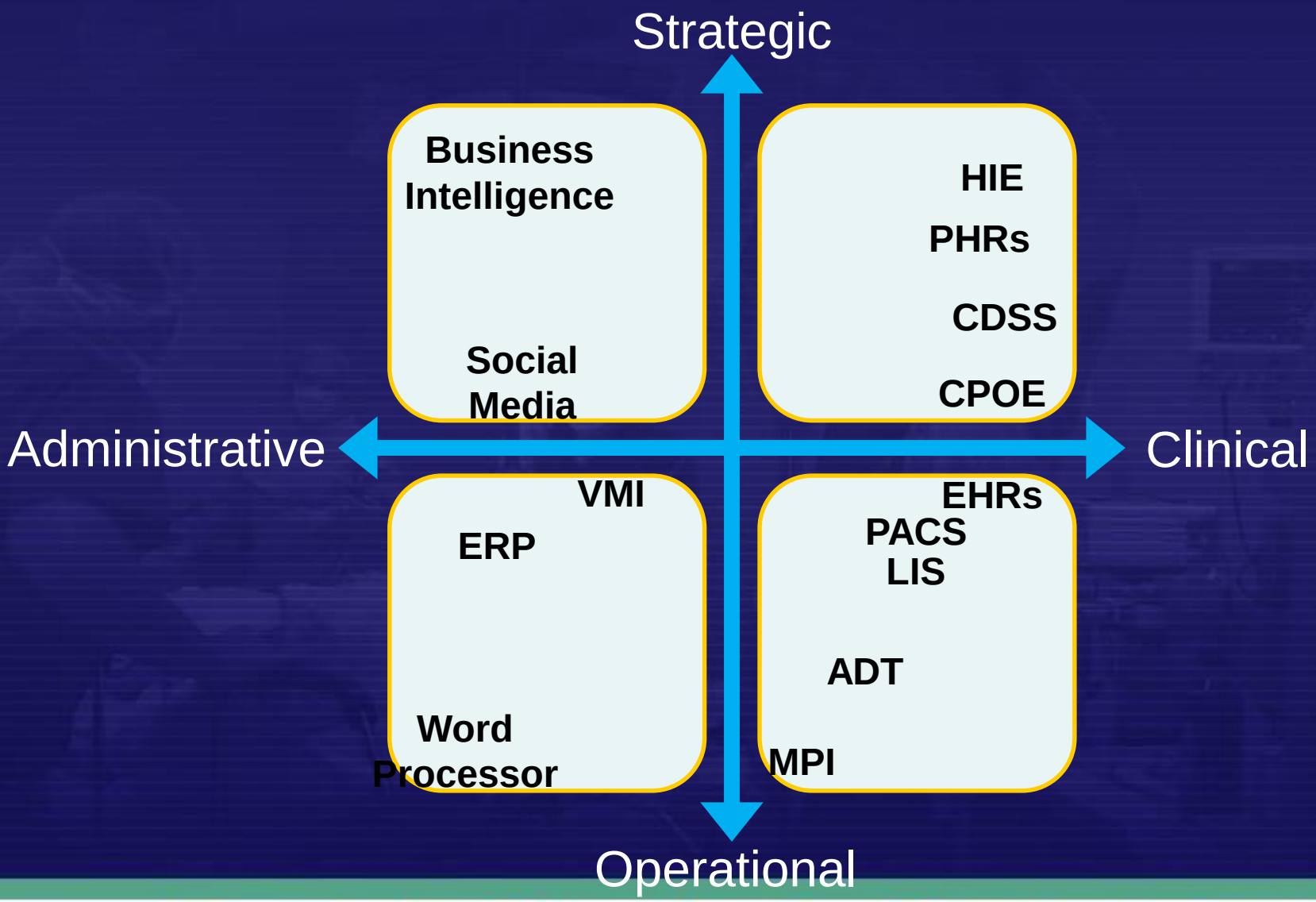
- Choosing the right CDSS strategies
- Expertise required for proper CDSS design & implementation
- Integration into the point of care with minimal productivity/ workflow impacts
- Everybody agreeing on the “rules” to be enforced
- Maintenance of the knowledge base
- Evaluation of effectiveness

“Ten Commandmends” for Effective CDSSs

- Speed is Everything
- Anticipate Needs and Deliver in Real Time
- Fit into the User’s Workflow
- Little Things (like Usability) Can Make a Big Difference
- Recognize that Physicians Will Strongly Resist Stopping
- Changing Direction Is Easier than Stopping
- Simple Interventions Work Best
- Ask for Additional Information Only When You Really Need It
- Monitor Impact, Get Feedback, and Respond
- Manage and Maintain Your Knowledge-based Systems

(Bates et al., 2003)

4 Quadrants of Health IT



Health Information Exchange

Hospital A

Government

Hospital B

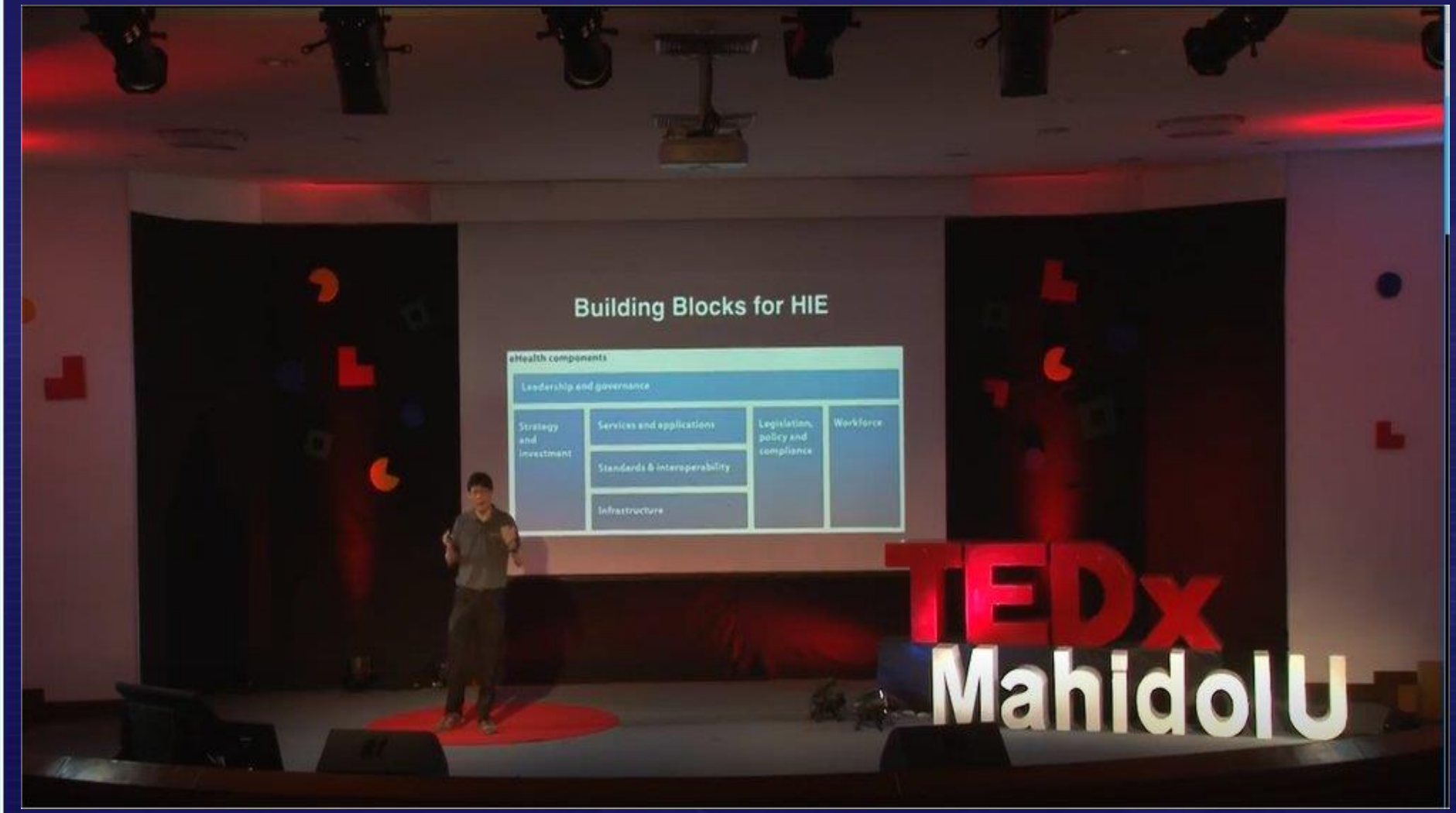
Lab

Patient at Home

Clinic C

My Life-Long Mission...

YouTube: TEDxMahidolU Nawanan



https://www.youtube.com/watch?v=MuoDaJAqQ6c

Take-Away Messages

- Health IT in clinical settings comes in various forms
- Local contexts are important considerations
- Clinical IT is a very complex environment
- Health IT has much potential to improve quality & efficiency of care
- But it is also risky...
  - Costs
  - Change resistance
  - Poor design
  - Alert fatigue
  - Workarounds and unintended consequences
  - Use of wrong technology to fix the wrong process for the wrong goal
- We need to have an informatician's mind (not just a technologist's mind) to help us navigate through the complexities

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