

Health IT in Clinical Settings

Nawanan Theera-Ampornpunt, MD, PhD



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

October 20, 2022 [SlideShare.net/Nawanan](https://www.slideshare.net/Nawanan)

Except where
citing other works



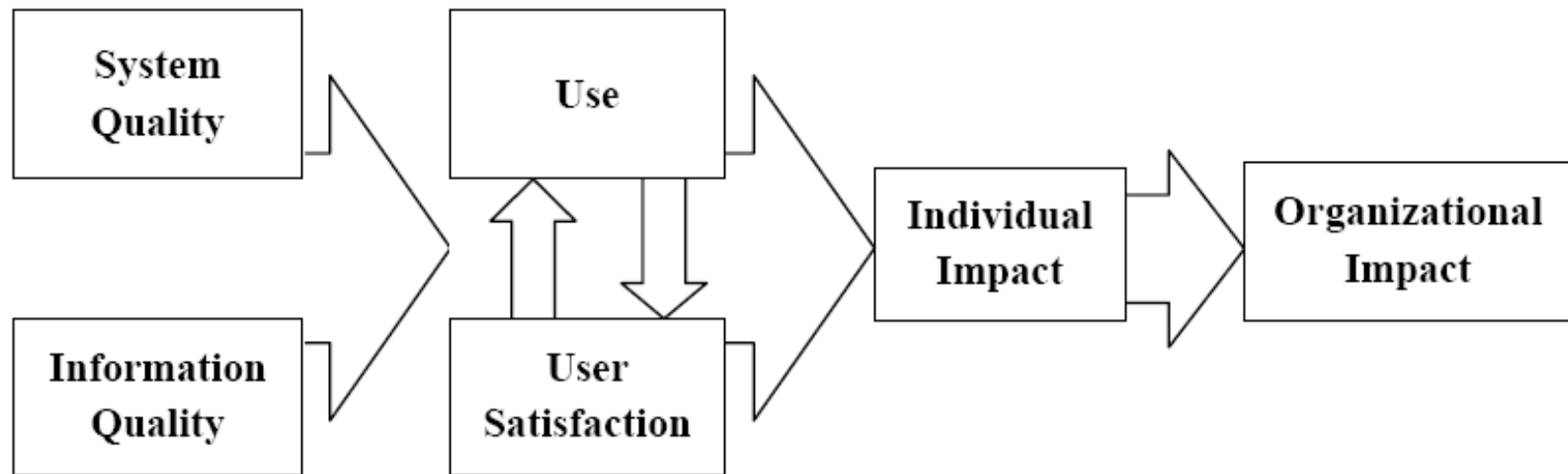
IT Decision Making in Hospitals: Key Points

- 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
- EHRs/EMRs/HIS/CIS
- CPOE & CDSSs
- Nursing applications
- Billing, Claims & Reimbursements
- MIS, ERP, CRM, DW, BI



Examples of Hospital IT

Departmental Applications

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

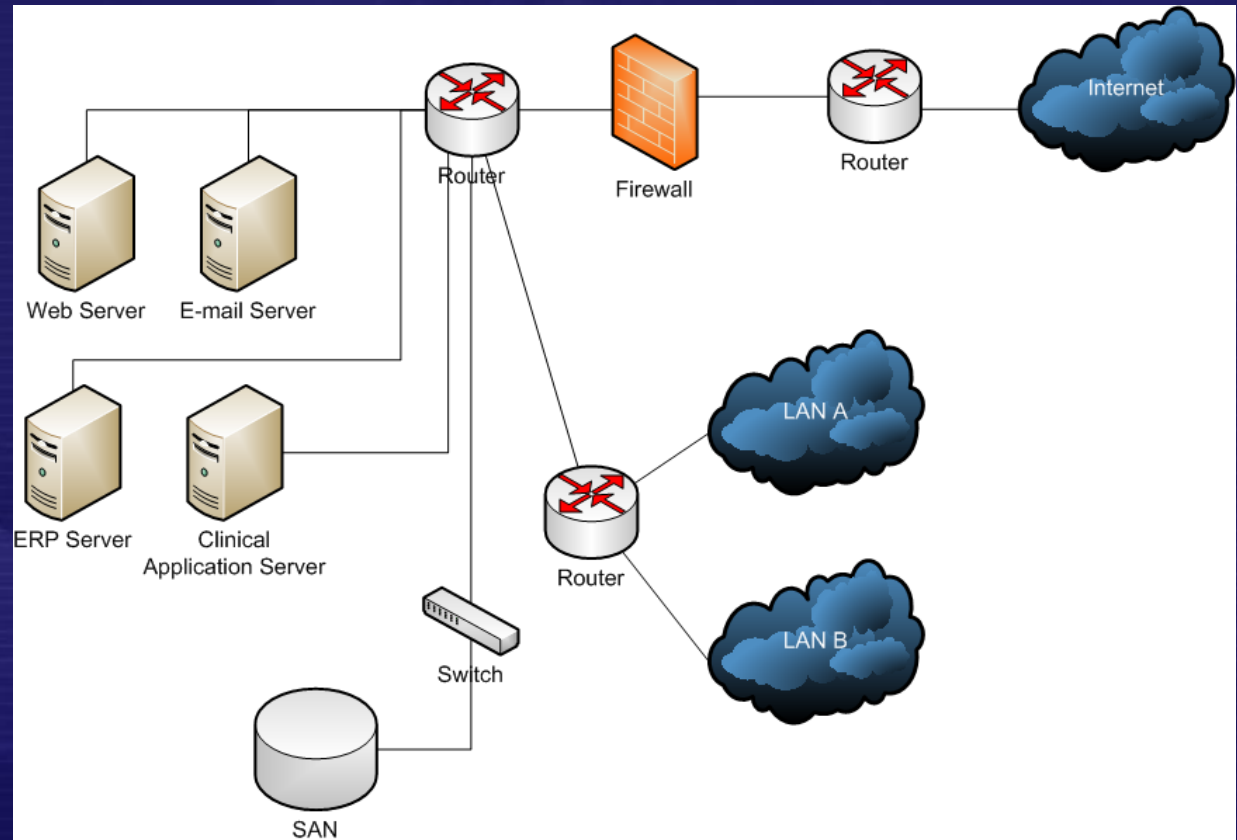


The IT Infrastructure



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



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**

- 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

The Challenge - Knowing What It Means

**Electronic Health
Records (EHRs)**

**Electronic Medical
Records (EMRs)**

**Electronic Patient
Records (EPRs)**

**Computer-Based
Patient Records
(CPRs)**



**Hospital
Information
System (HIS)**

**Personal Health
Records (PHRs)**

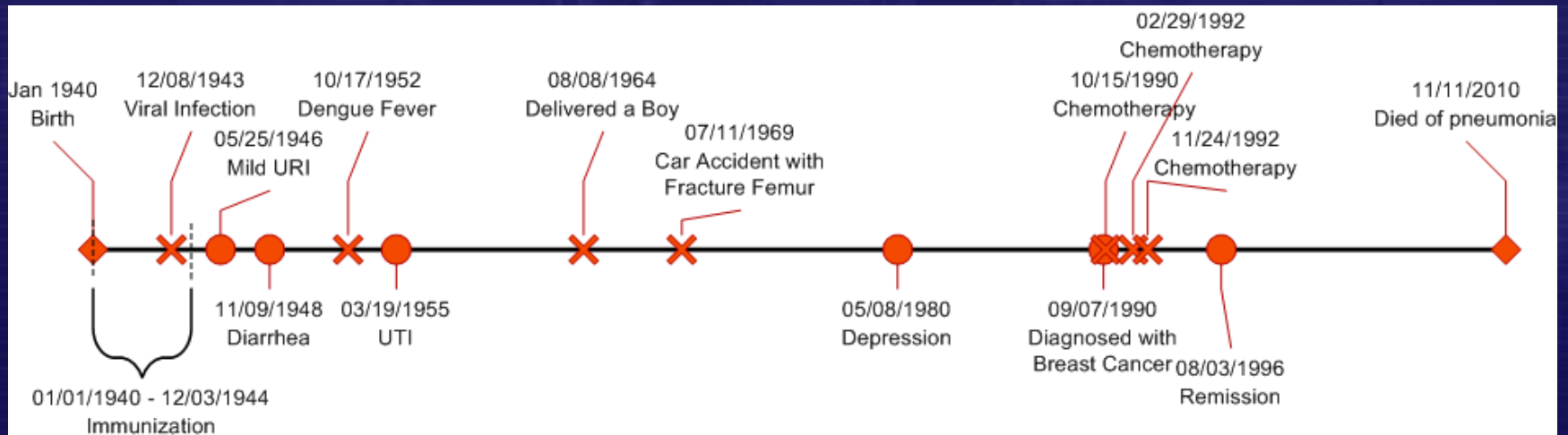
**Clinical
Information
System (CIS)**



EHRs

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?



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)
- **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



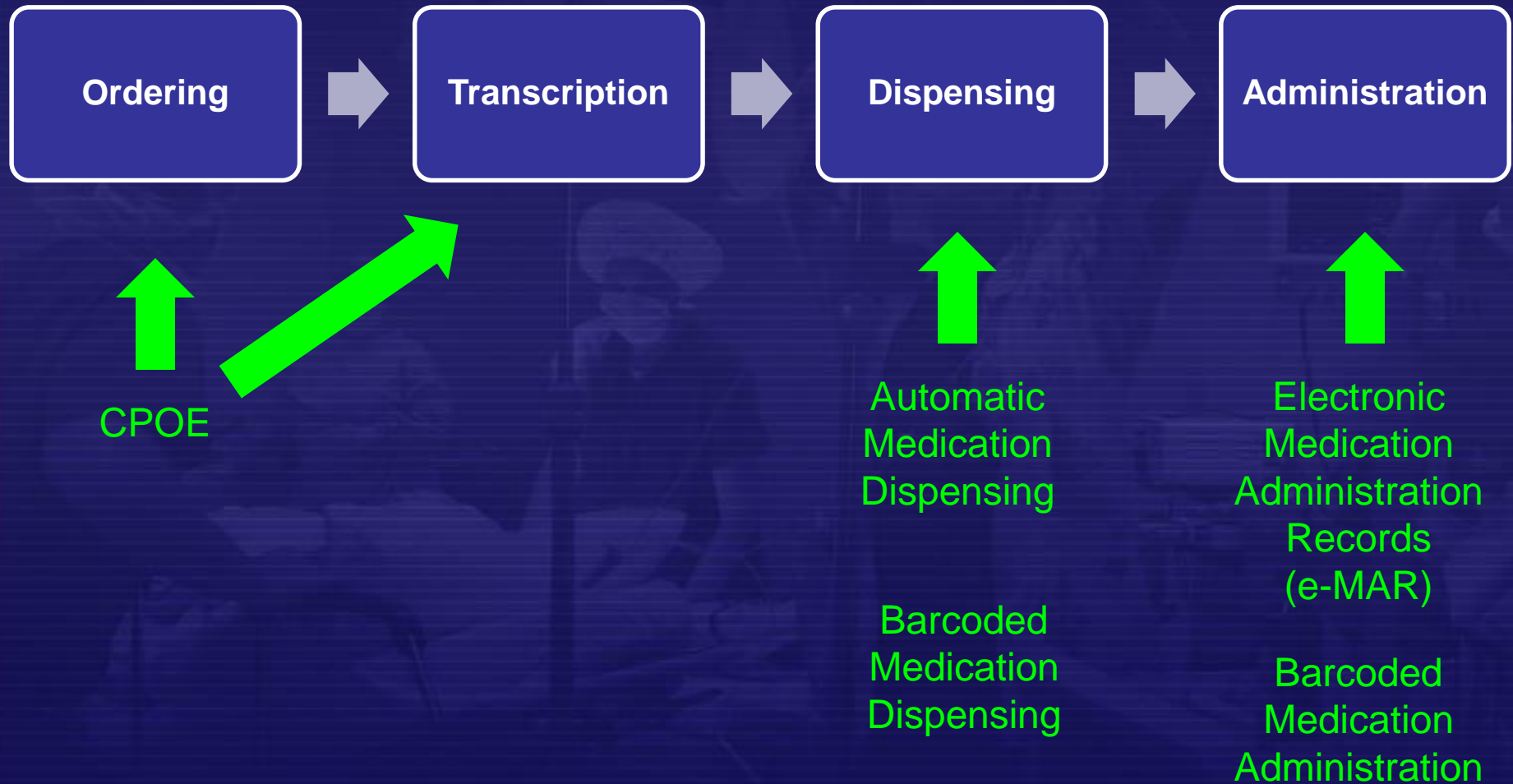
Pharmacy Applications

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)

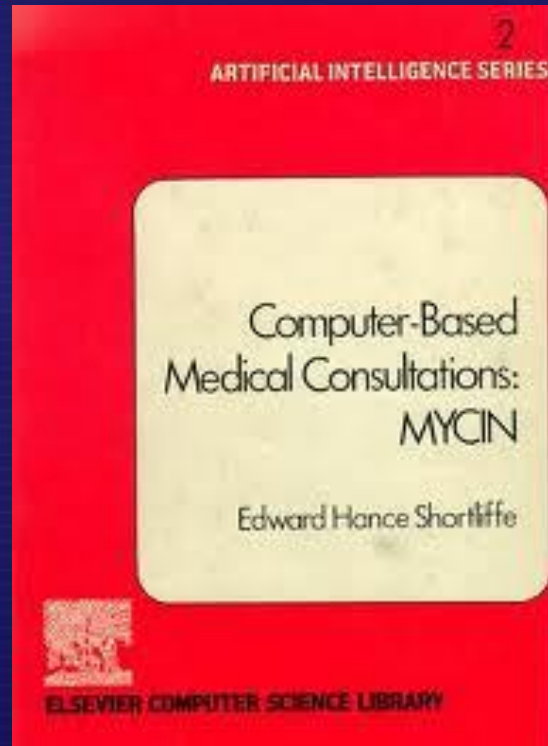
- Captures, archives, and displays electronic images captured from imaging modalities (DICOM format)
- Often refers to radiologic images but sometimes used in other settings as well (e.g. cardiology, endoscopy, pathology, ophthalmology)
- Values: reduces space, costs of films, loss of films, parallel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

SANDIEGO, CARMEN 27y M (-) [Name](#) [List](#) [Add to list](#)

Out Patient • Show ☒ Active ☐ Hold ☐ [Print](#) [Print One-Time](#)

S	U	Status	Drug Name	Dose	Last Changed	Provider
<input type="checkbox"/>		A	Abciximab Preparation 	1 Tablet(s) QD/OD (ONCE A DAY) PO (BY MOUTH)	2004-10-11 12:49	
<input type="checkbox"/>		A	Humulin 50/50 U100 	40/16 Unit(s) (u) MIDNIGHT PO (BY MOUTH)	2004-09-24 14:43	
<input type="checkbox"/>		A	Bicillin La 600,000 U 	1 Tablet(s) QD/OD (ONCE A DAY) PO (BY MOUTH)	2004-09-08 14:56	
<input type="checkbox"/>		A	Humulin R 100u/ml 10 	40/16 Unit(s) (u) QD/OD (ONCE A DAY) PO	2004-08-24 11:42	

Rx Abciximab Preparations 

Modify	Print	Status: A
Drug Dose Units:	1 Tablet(s)	Refills: 5
Route:	PO (BY MOUTH)	Quantity Dispensed: 30 Tablet(s)
Frequency:	QD/OD (ONCE A DAY)	Label In Spanish: N
Duration:		Non Child Proof: N
PRN:	N	DAW: N
Order Time:	2004-10-11	Provider: Chen, Cynthia
Doctor's Instructions:		

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



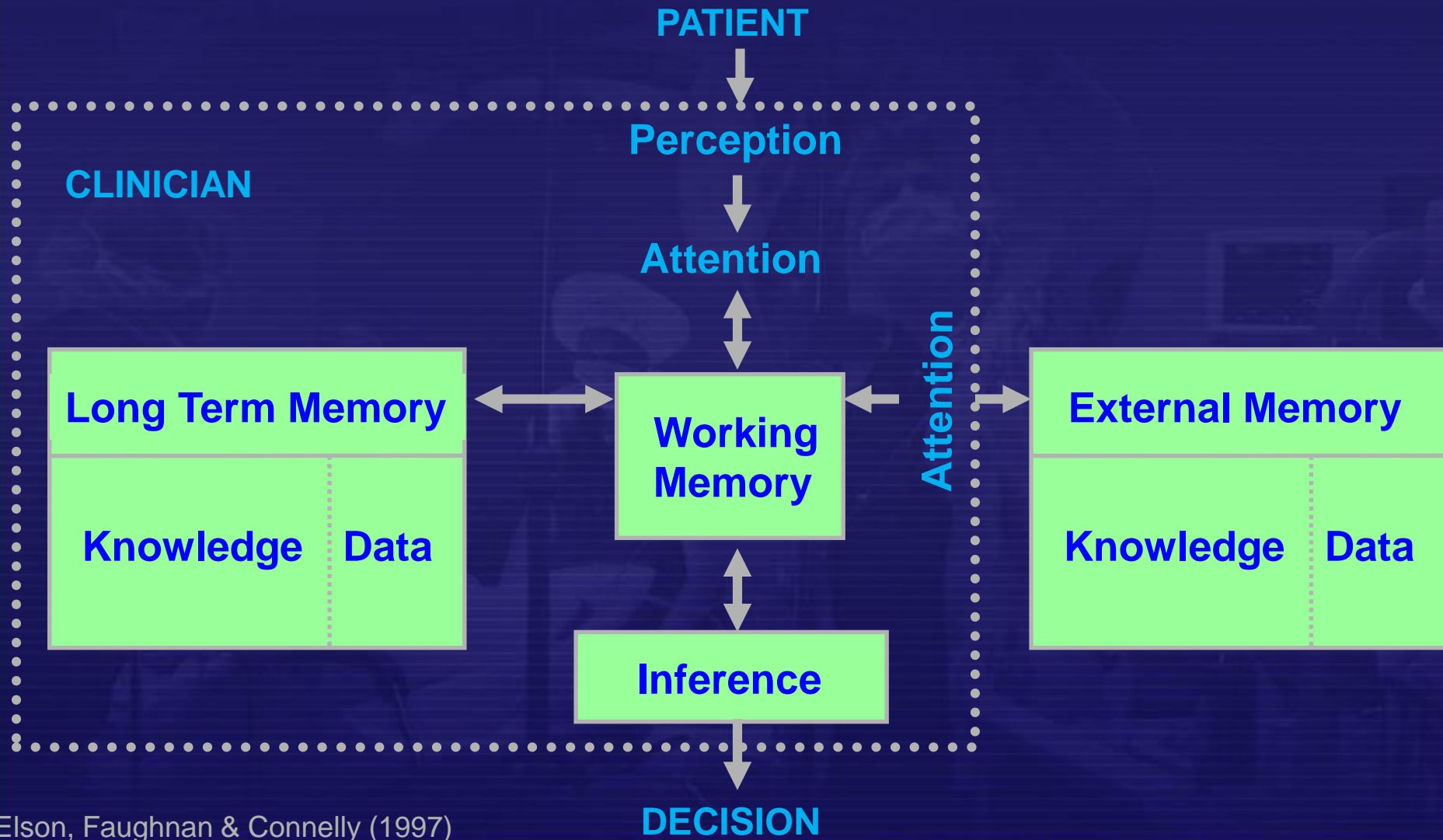
Abnormal Lab Highlights

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	<input type="checkbox"/> Expand Display	From Date 10/22/06						
Blood											
Hematology											
<input type="checkbox"/> 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	
<input type="checkbox"/> DIFFERENTIAL		Neuts	Bands	Lymphs	Monos	Eos	Baso	Atyps	Metas	Myelos	Promye
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	
<input type="checkbox"/> 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				

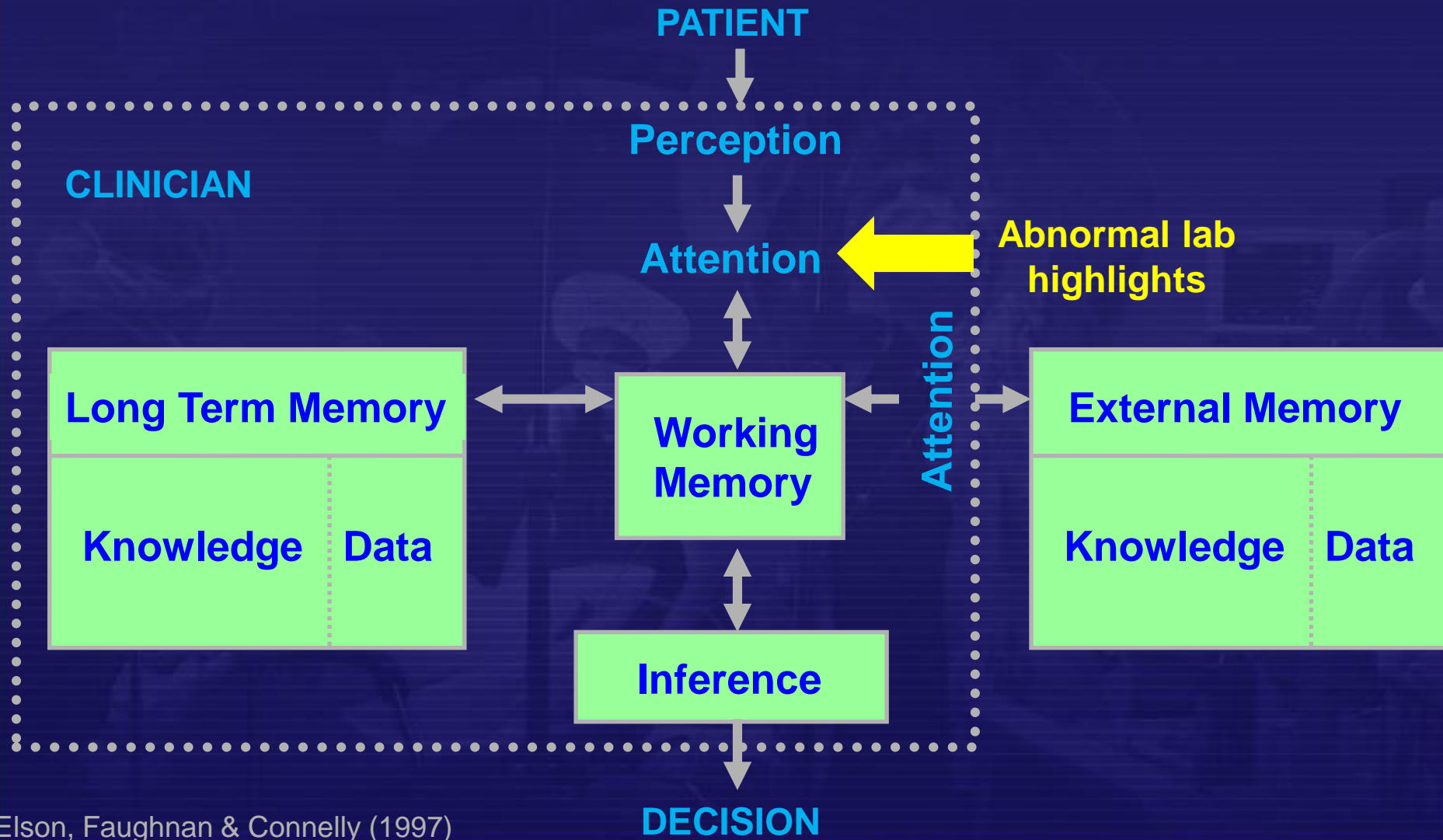
Image Source: <http://geekdoctor.blogspot.com/2008/04/designing-ideal-electronic-health.html>



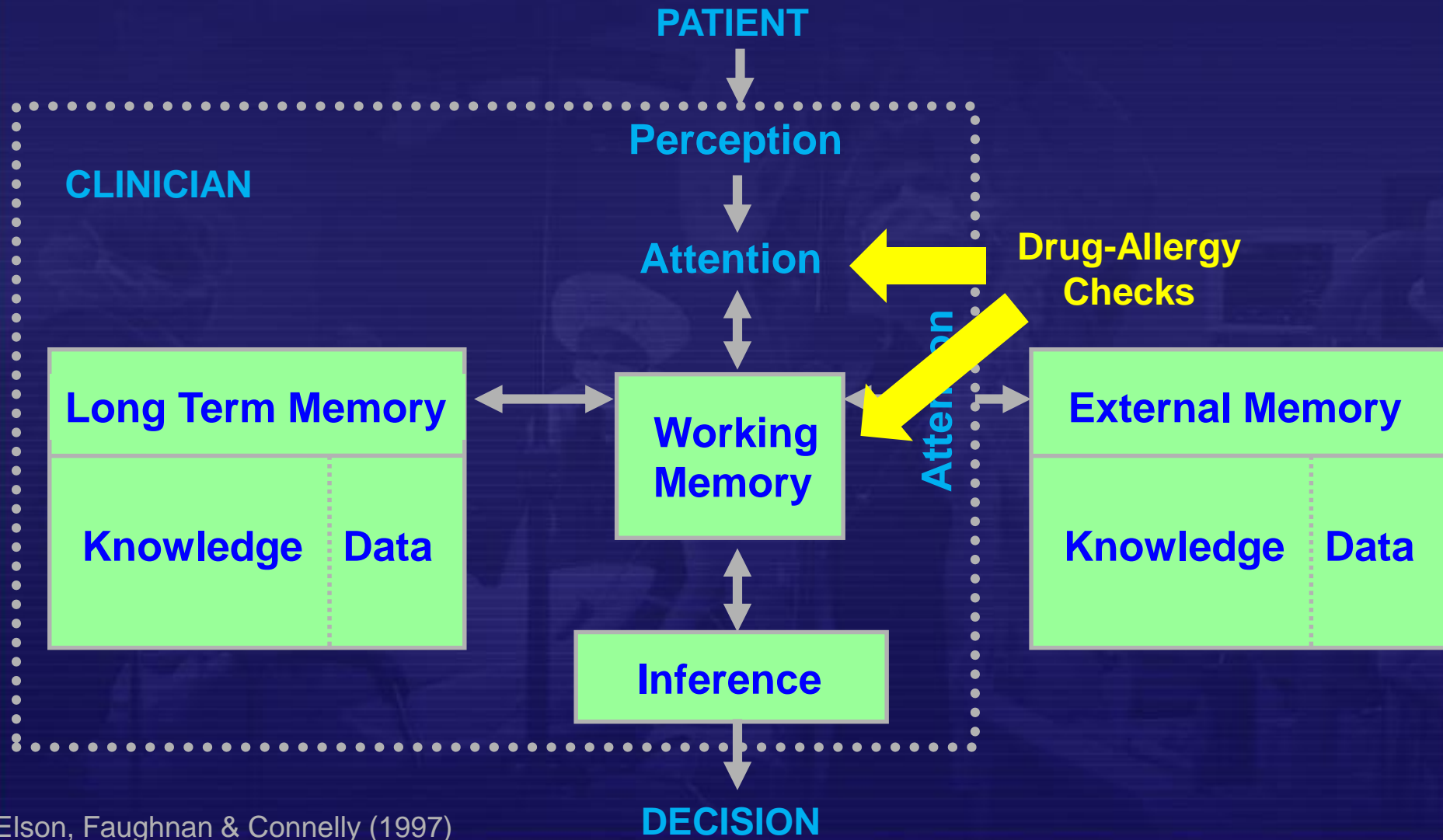
Clinical Decision Making



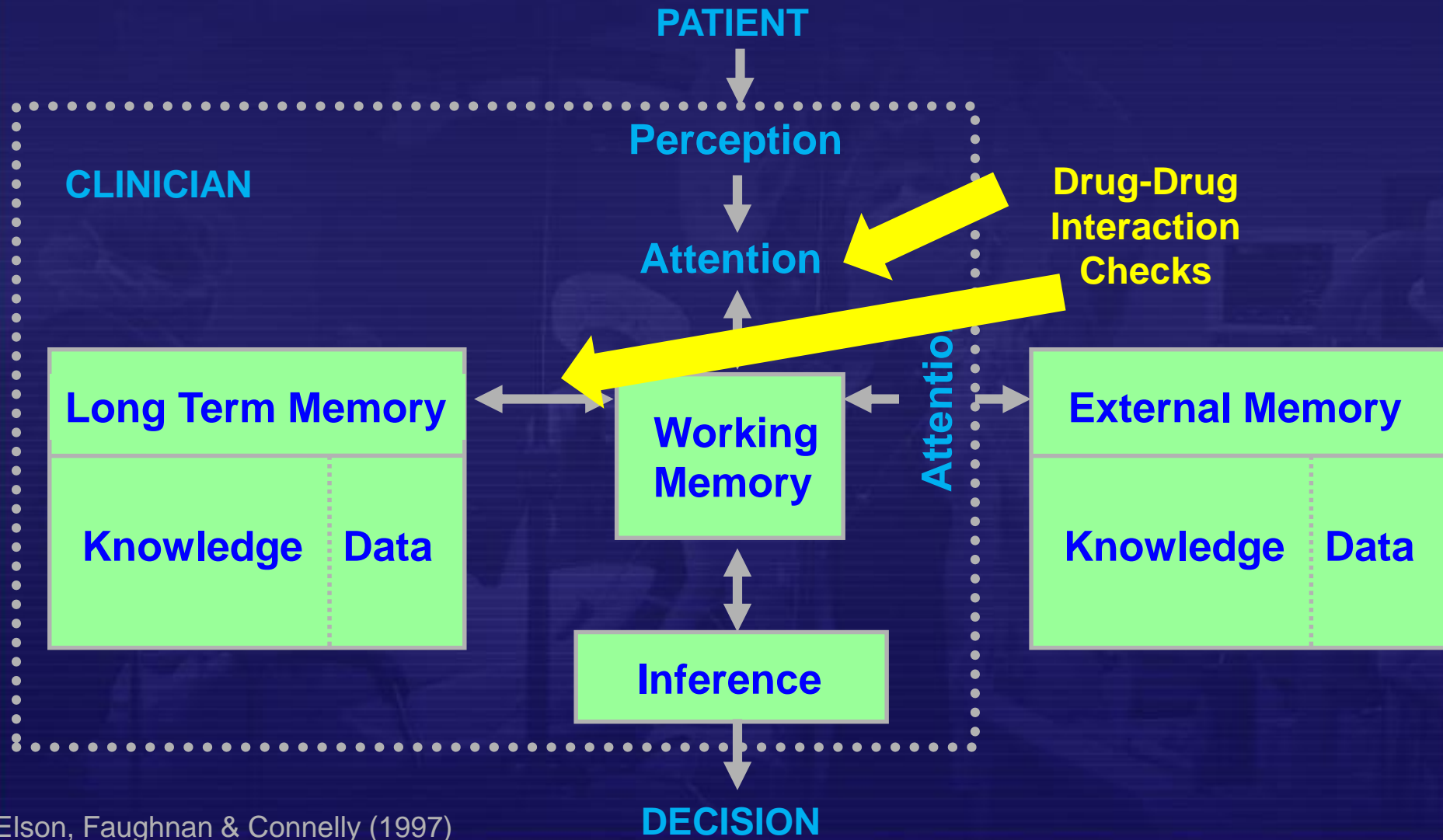
Clinical Decision Making



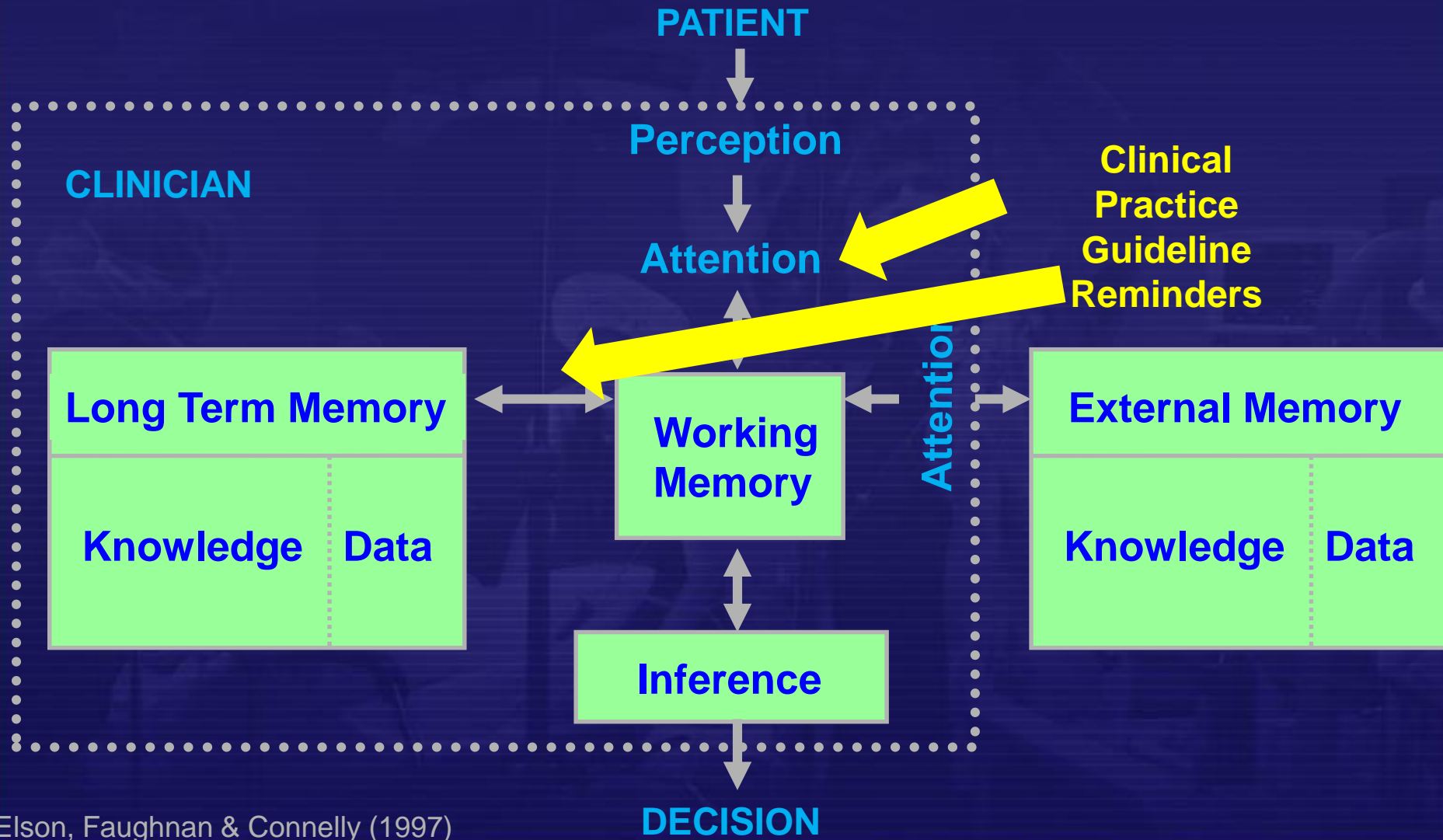
Clinical Decision Making



Clinical Decision Making



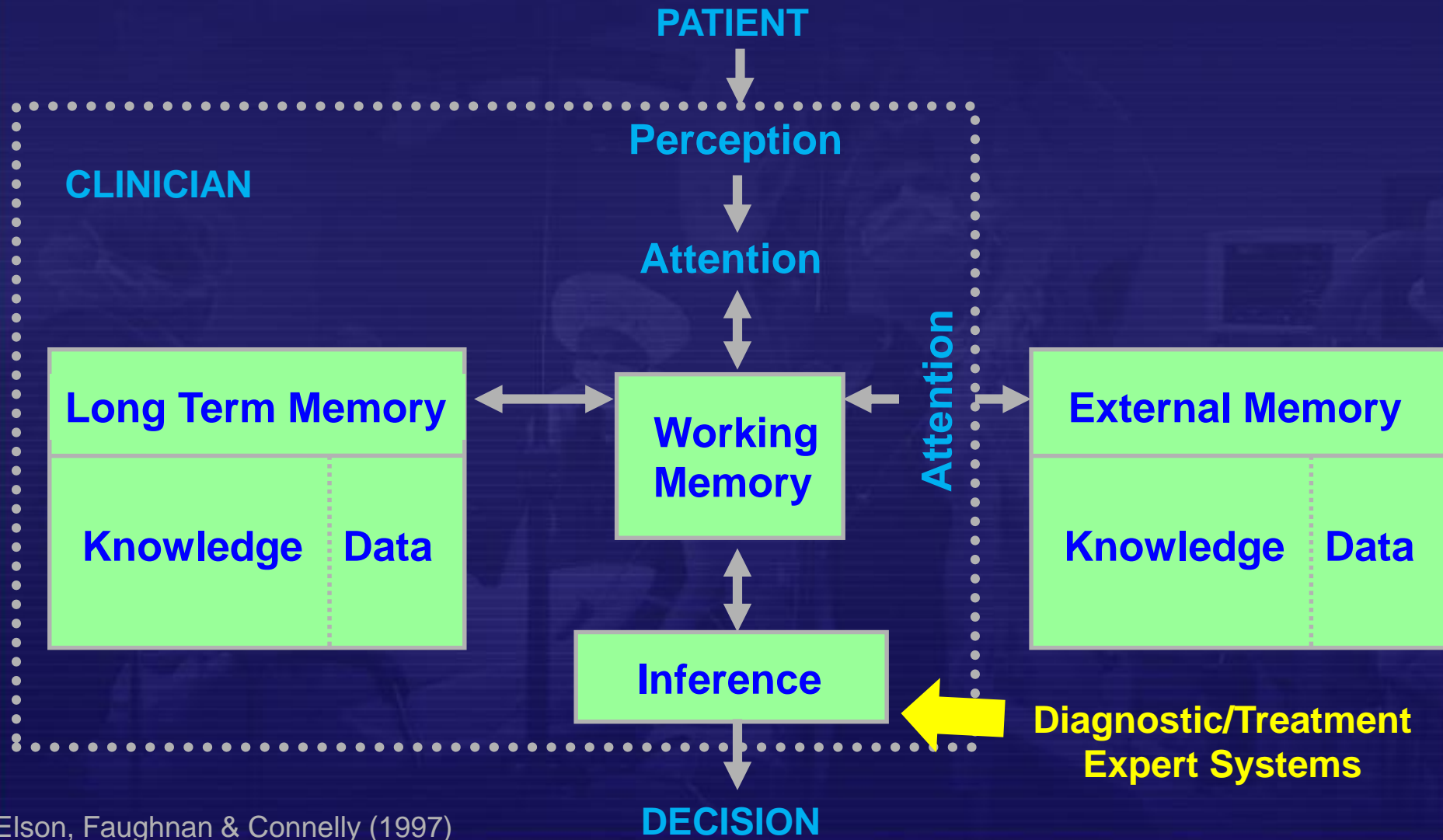
Clinical Decision Making



Elson, Faughnan & Connelly (1997)



Clinical Decision Making



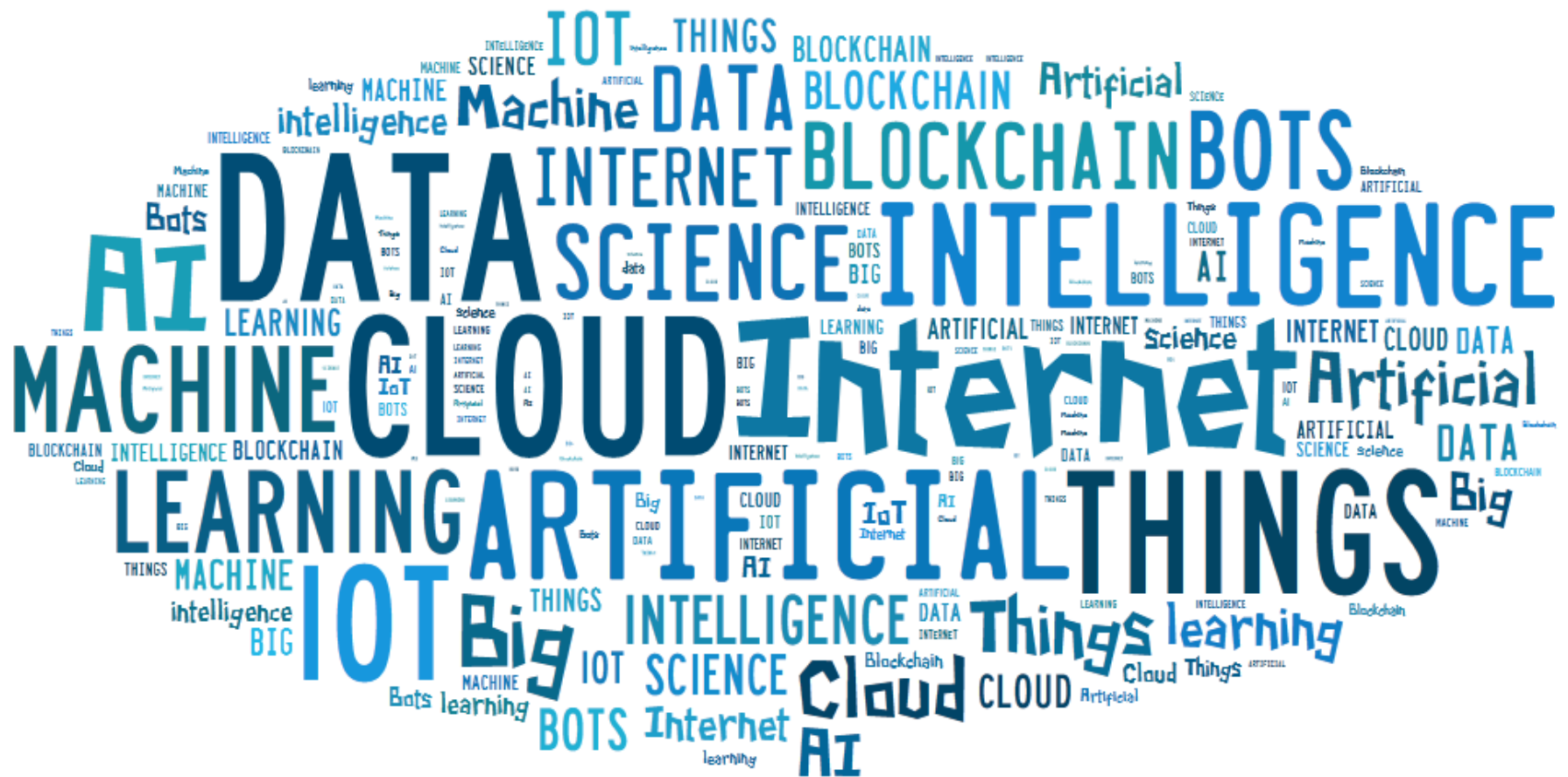
Elson, Faughnan & Connelly (1997)



What words come to mind when you hear...

Digital Health Transformation





Copyright 2016

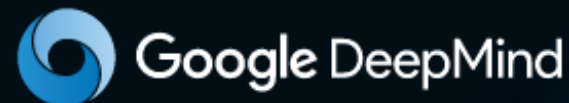
tagxedo.com

<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



<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?




Digitizing Healthcare



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



"Fun but incisive read."
—Deccan Chronicle



SMART PHONES DUMB PEOPLE?

Using 21st Century Tools
To Address 19th Century Issues

PARTHAJEET SARMA
An Award Winning Innovator



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...”



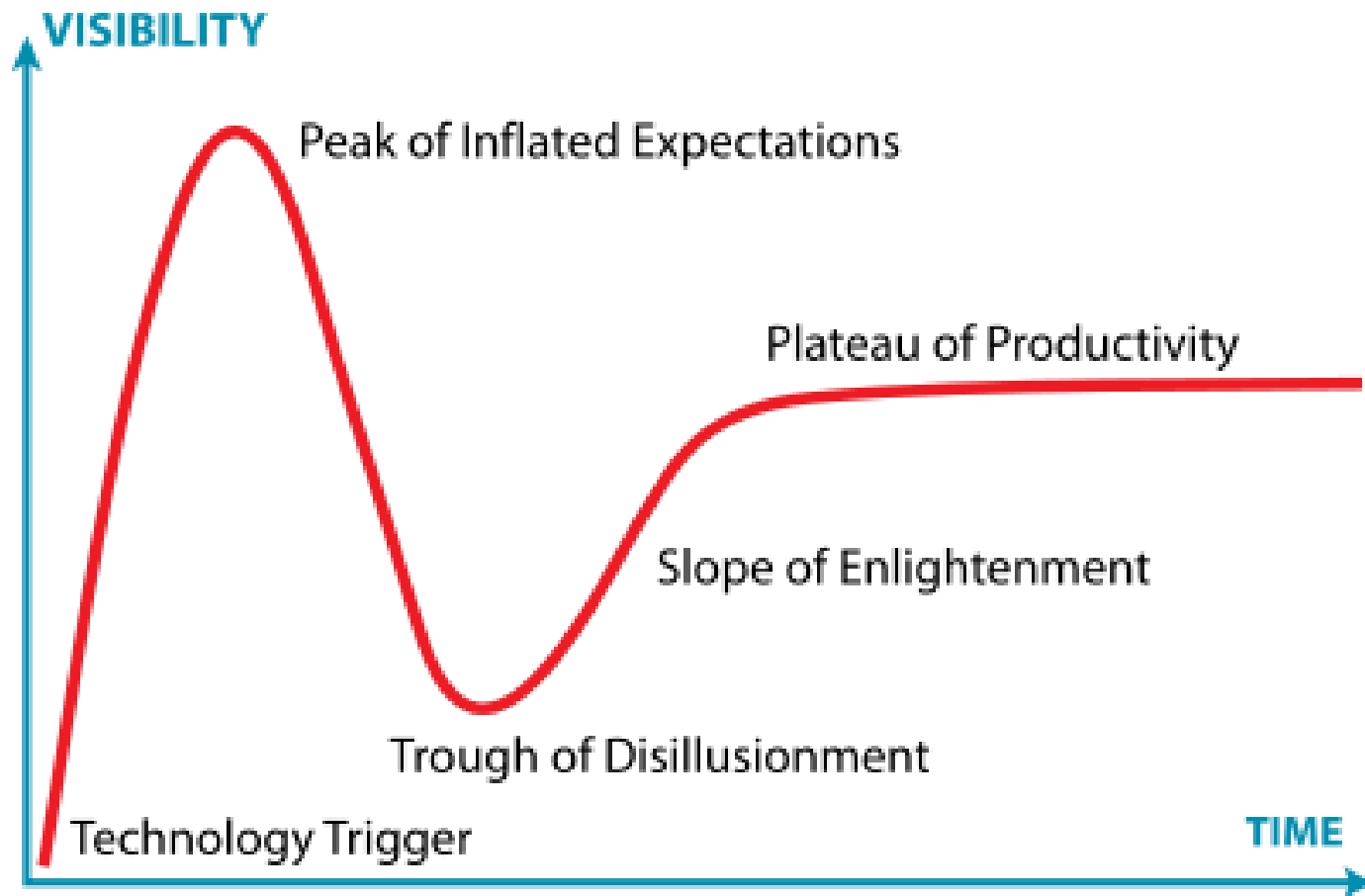
-- Dan Ariely @danariely (2013)

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

-- Nawanat Theera-Ampornpant (2018)



Hype vs. Hope

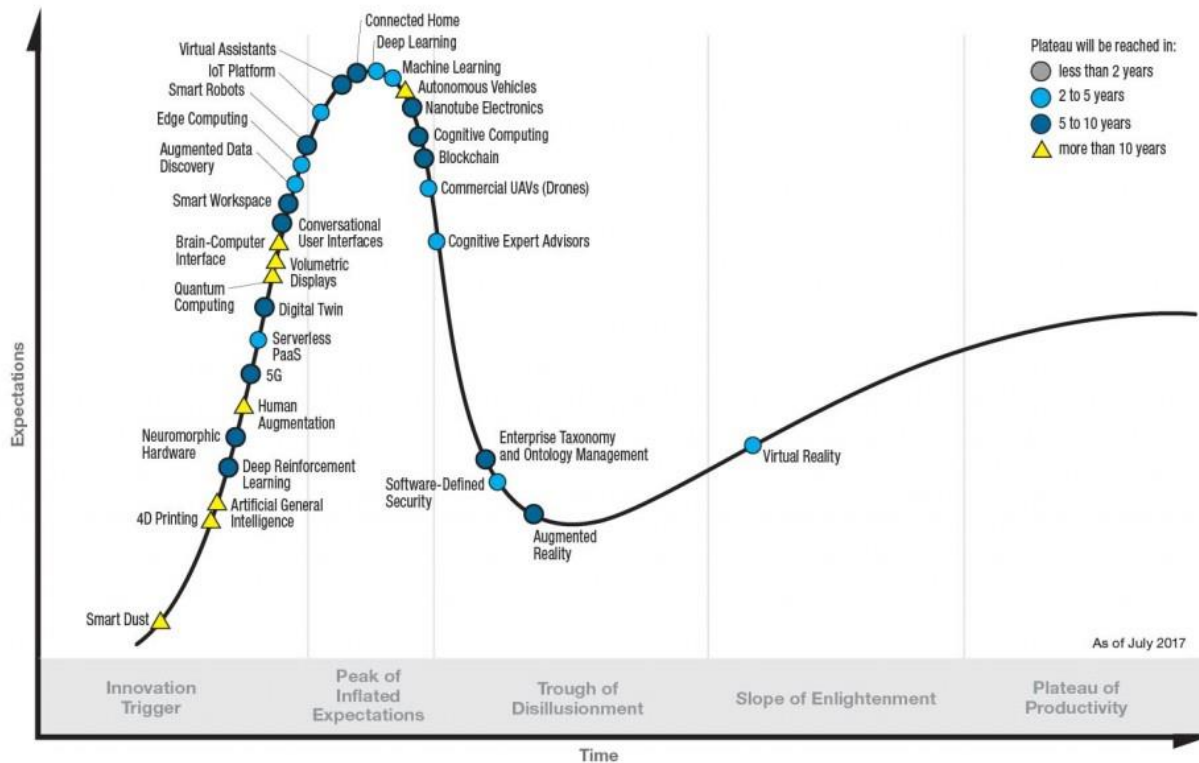


Jeremy Kemp via http://en.wikipedia.org/wiki/Hype_cycle
<http://www.gartner.com/technology/research/methodologies/hype-cycle.jsp>



Gartner Hype Cycle 2017

Gartner Hype Cycle for Emerging Technologies, 2017



gartner.com/SmarterWithGartner

Source: Gartner (July 2017)
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“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?

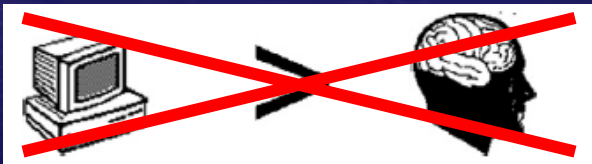
- Machines are (at best) as good as the input data
 - Not everything can be digitized or digitally acquired
 - Not everything digitized is accurate (“Garbage In, Garbage Out”)
- Experience, context & human touch matters



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 \neq Digital Transformation



Being Smart #1: Stop Your “Drooling Reflex”!!



**Being Smart #2:
Focus on Information &
Process Improvement,
Not Technology**



“Smart Hospital”





The Goal of Health Care

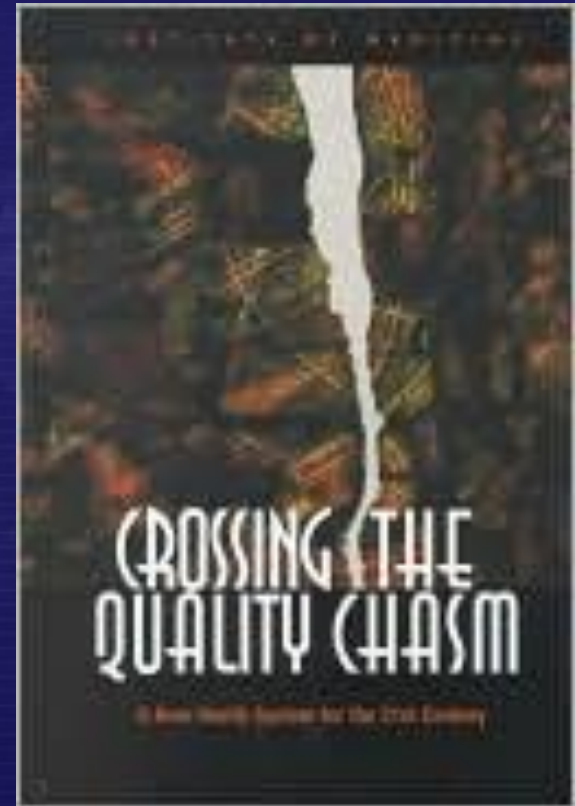
The answer is already obvious...

“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

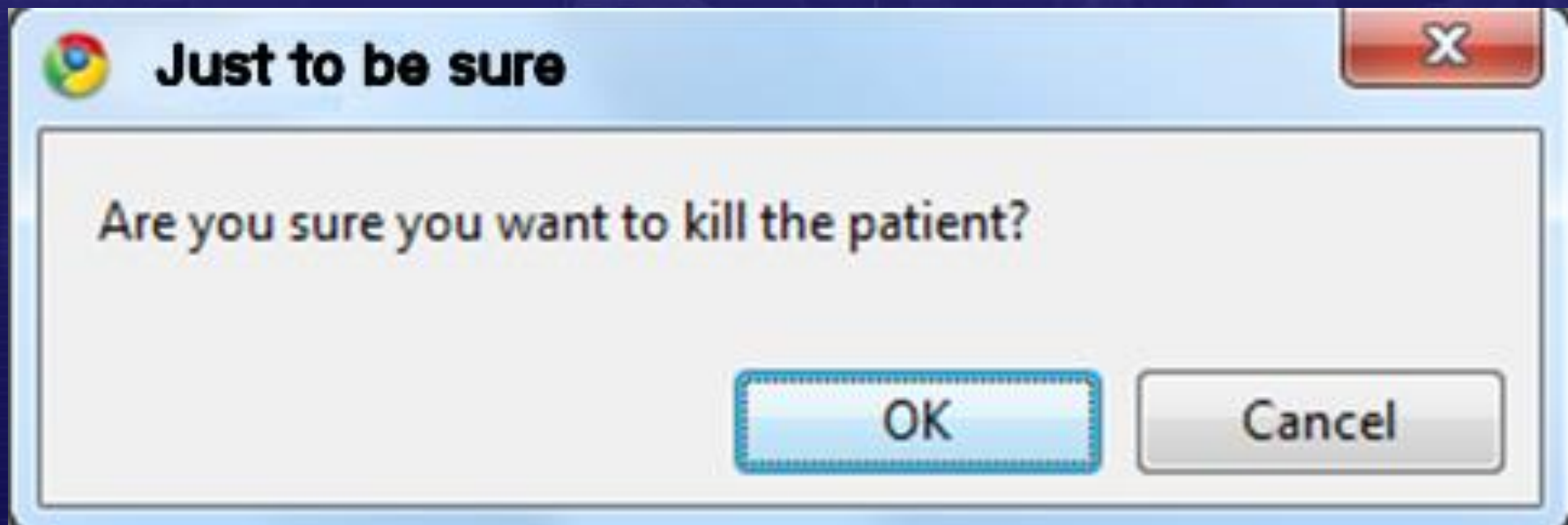
← Means/Tools



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

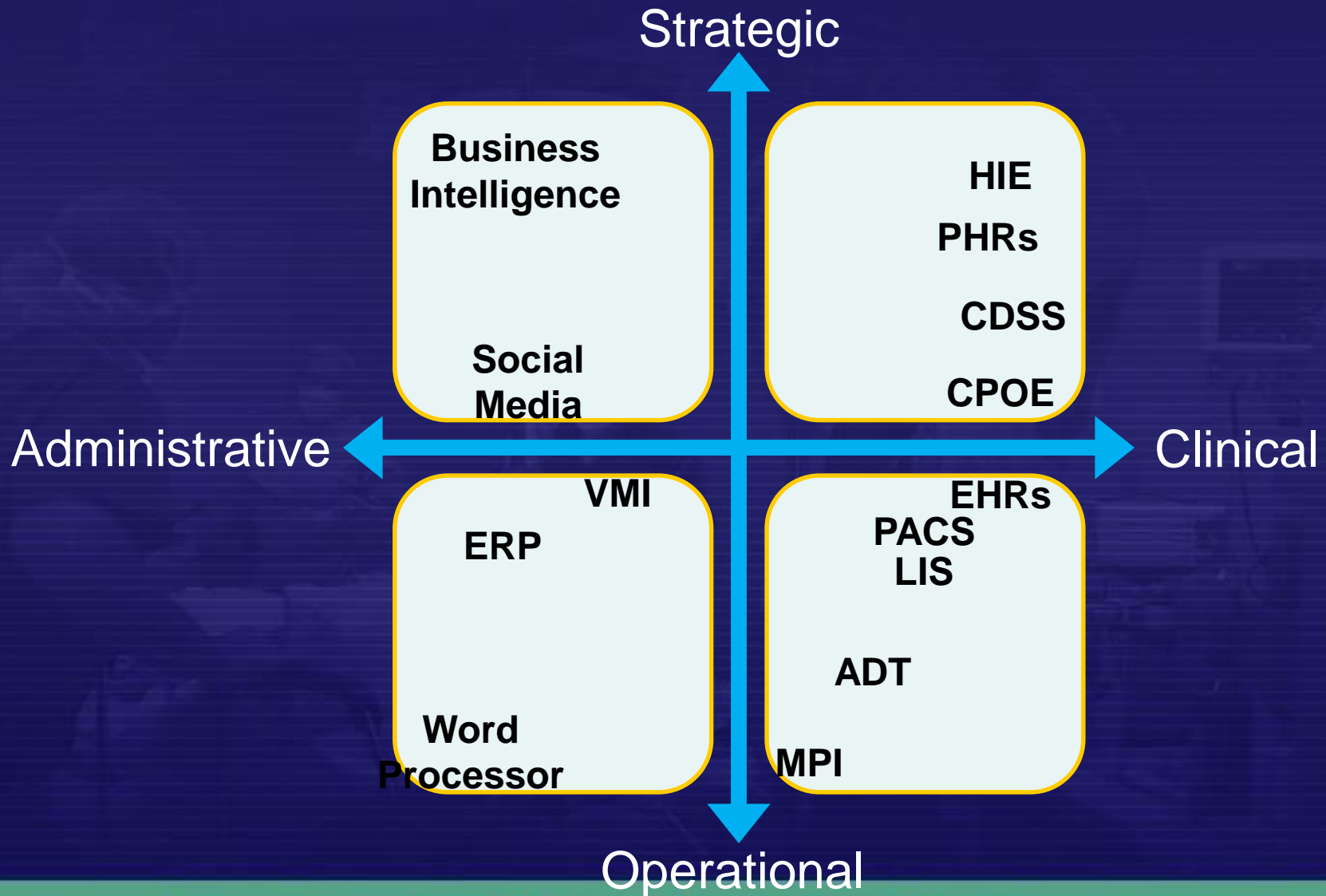


“Ten Commandments” for Effective CDSSs

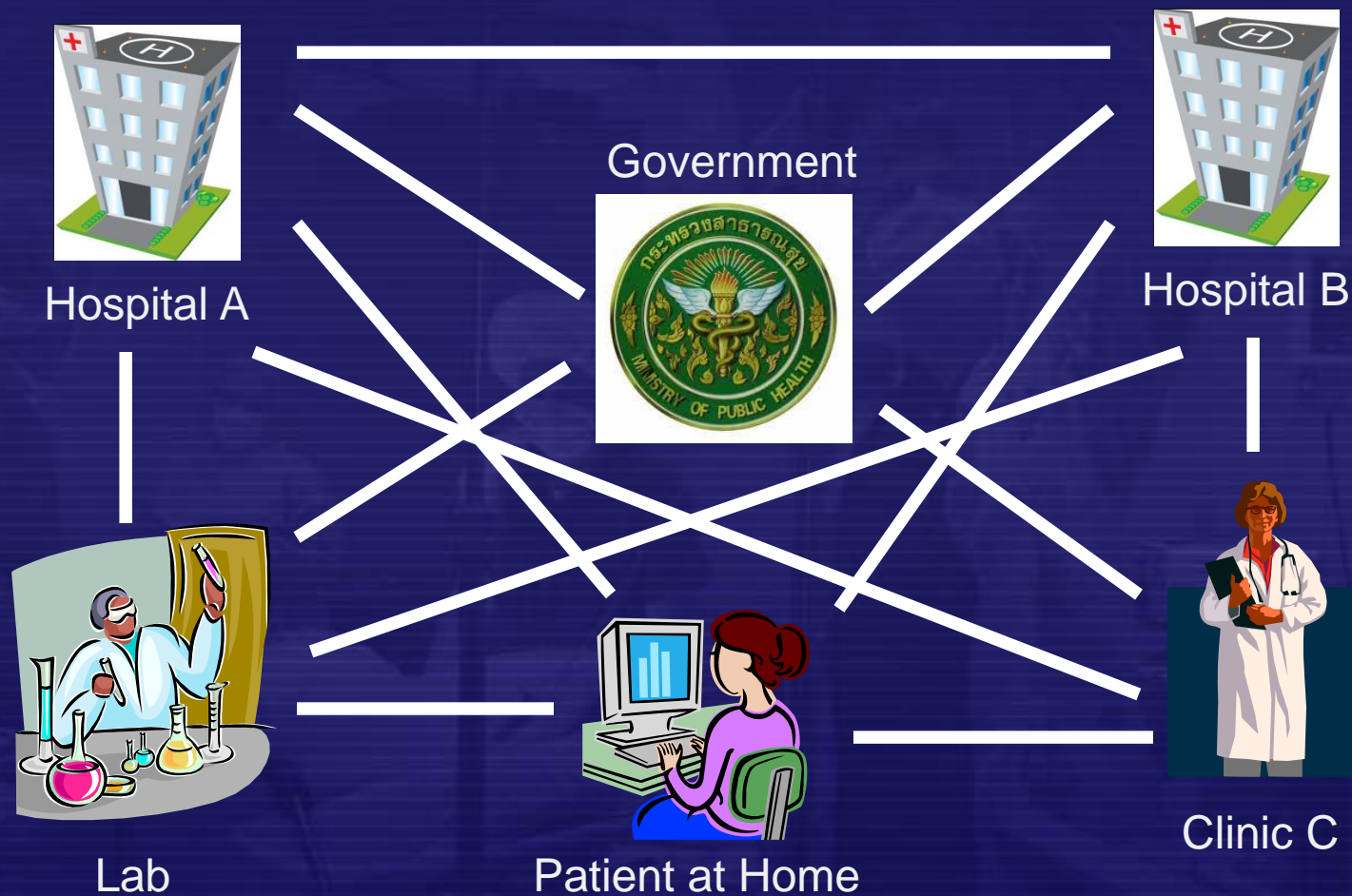
- Speed is Everything
 - Anticipate Needs and Deliver in Real Time
 - Fit into the User’s Workflow
 - Little Things (like Usability) Can Make a Big Difference
 - Recognize that Physicians Will Strongly Resist Stopping
 - Changing Direction Is Easier than Stopping
 - Simple Interventions Work Best
 - 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



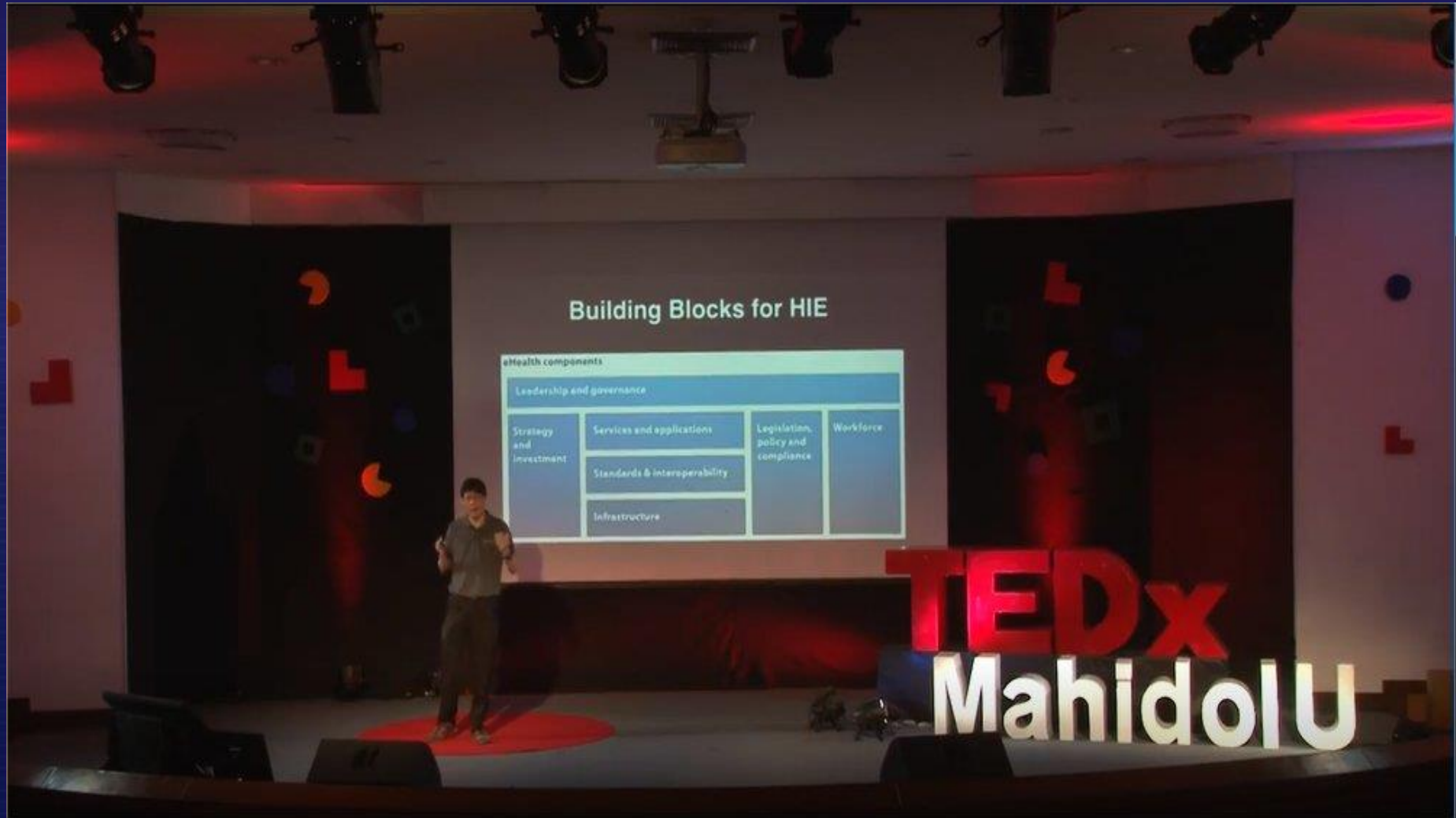
Health Information Exchange



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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