# Evaluating Test Utilization

Clinical Informatics Lecture

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# Learning objectives

- Describe criteria for evaluating lab test utilization
- List resources for expert recommedations on lab utilization
- Demonstrate resources for monitoring test utilization at BJH/BJC

Course materials at: https://github.com/MarkZaydman/PathologyInformatics_2021.git

# Why this lecture matters

- Laboratory testing represents a significant healthcare expenditures
- Inapproapriate lab utilization drives waste, additional testing, treatment, and harms
- Evaluating laboratory utilization will be an important component of your QI project

# Defining appropriate laboratory utilization

- Evidence based
- Non-redundant
- Free from harm (or at least a net benefit)
- Necessary

(Adopted from choosingwisely.org/our-mission)

# "The three rules of laboratory test utilization"

1. Stupid question gets a stupid answer
2. Testing is for sick people
3. Too many good tests is the same as one bad test

(Baird et al 2014 *Biochemia Medica*)

# Considerations

- Right patient?
- Right test?
- Right interval?

**Misutilization can manifest as overutilization or underutilization**

# Right patient?

- Is the patient at a reasonable risk for the disease?
- Has the diagnosis already been established?
- Is a treatment available for this patient/disease?

# Right patient?

## Estimating prevalence from Se, Sp, and positivity rate

$$P(T^+) = P(T^+|D^+)P(D^+) + P(T^+|D^-)P(D^-)$$

$$P(T^+) = P(T^+|D^+)P(D^+) + P(T^+|D^-)(1 - P(D^+))$$

$$P(T^+) = P(T^+|D^+)P(D^+) + P(T^+|D^-) - P(T^+|D^-)P(D^+)$$

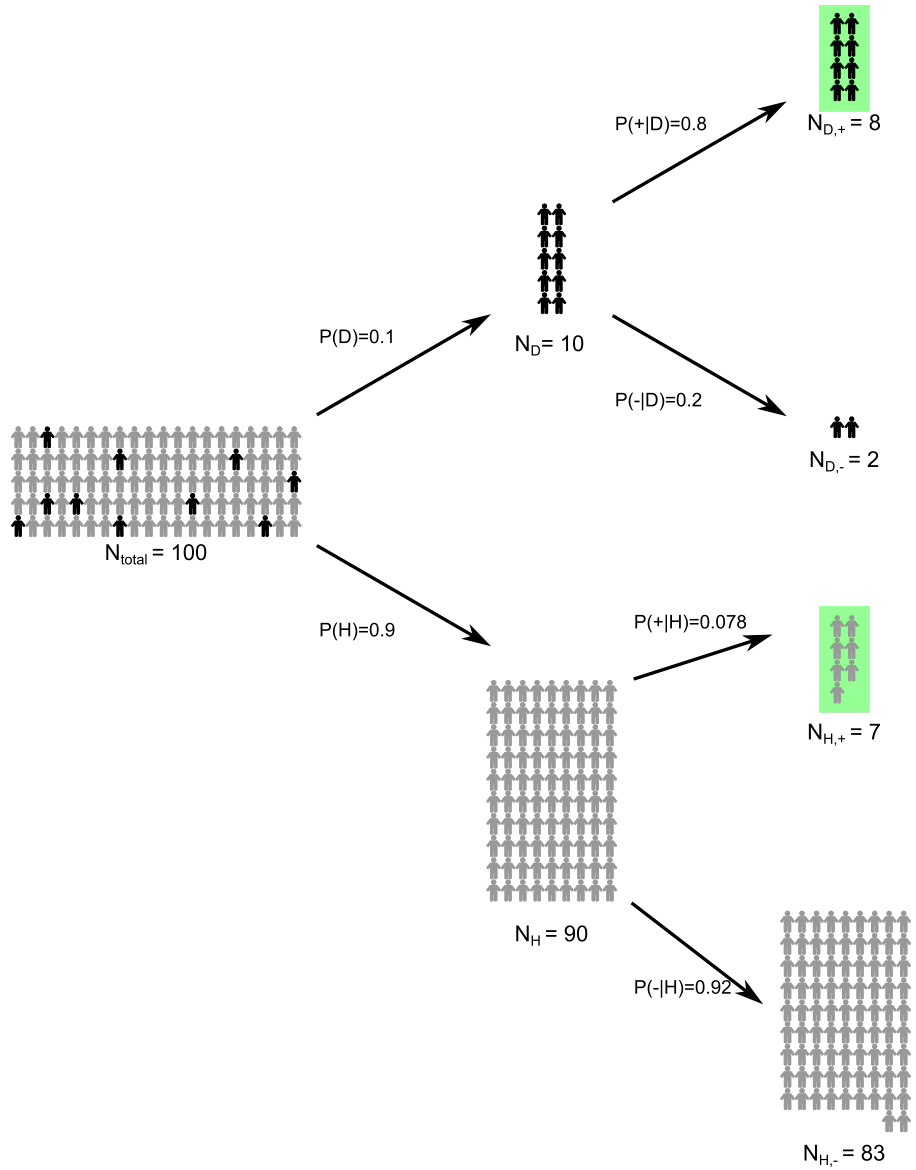
$$P(D^+) = \frac{P(T^+) - P(T^+|D^-)}{P(T^+|D^+) - P(T^+|D^-)} = \frac{P(T^+) - (1 - Sp)}{Se - (1 - Sp)}$$

# Backcalculate pretest probability (hypothetical test)

$$P(D^+) = \frac{P(T^+) - (1 - Sp)}{Se - (1 - Sp)} = \frac{\frac{15}{100} - (1 - 0.92)}{0.8 - (1 - 0.92)}$$

$$= \frac{0.15 - 0.08}{0.8 - 0.08} = \frac{0.07}{0.72} = 0.097 \approx 10\%$$

Hypothetical test: $Se = 0.8, Sp = 0.92$



# Was PF4 Ab testing ordered on the "right patients"?

(BJH data)

| # PF4 (%) | 2015 | 2016 | 2017** |
|---|---|---|---|
| **Total** | 1222 (100) | 1136 (100) | 238 (100) |
| **Positive** | 203 (16.6) | 220 (19.4) | 51 (21.4) |

# Backcalculate pretest probability (HIT testing at BJH)

HIT ELISA test: $Se = 0.97, Sp = 0.87$ (Nagler et al 2016 *Blood*)

$$P(D^+) = \frac{P(T^+) - (1 - Sp)}{Se - (1 - Sp)} = \frac{\frac{474}{2594} - (1 - 0.87)}{0.97 - (1 - 0.87)}$$

$$= \frac{0.183 - 0.13}{0.97 - 0.13} = \frac{0.003}{0.77} = 0.063 \approx 6.3\%$$

Background HIT prevalence $\approx 2.7\%$ (Warkentin 1995 *NEJM*)

Expert recommendation: only test 4T Int/High (Cuker et al. 2018 *ASH*, Linkins et al. 2012 *Chest*)

4T Int/High Pretest = 22% (Cuker et al 2012 *Blood*)

# Right test?

- Is a more accurate test available?
  - COVID-19 rapid antigen vs **COVID-19 RNA PCR**
- Is a cheaper test available that provides the same info?
  - Whole geneome vs **HFE gene mutation (PCR)**
- Is a test available that provides a result in a more suitable time frame?
  - **PF4 Ab** vs SRA

# Right test? (ionized calcium)

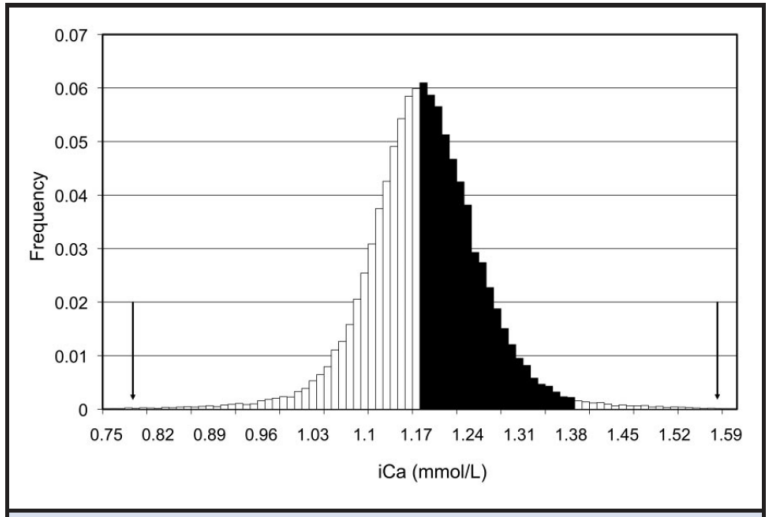
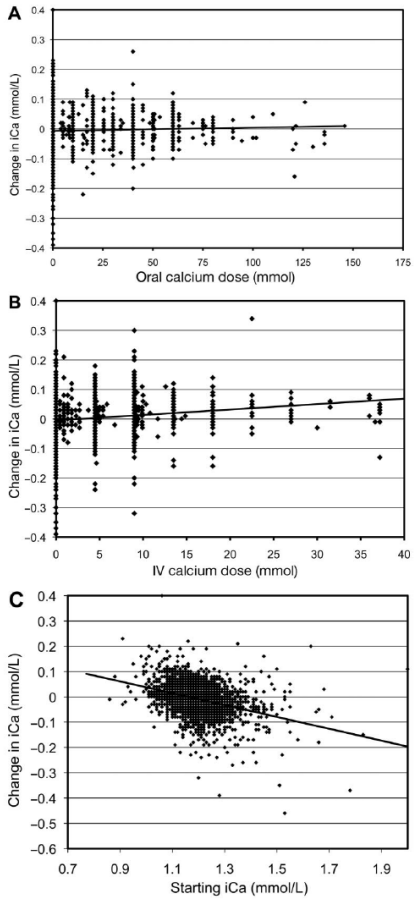



**Fig. 1. Histogram of 58 040 iCa results.**

The reference interval (shaded in black) is 1.18–1.38 mmol/L, and high and low critical values (1.58 mmol/L and 0.78 mmol/L) are indicated by black arrows.




Standard daily ionized calcium drove complex testing and unproven supplementation

(Baird et al 2009 *Clin Chem*)

# Right test? (ionized calcium)

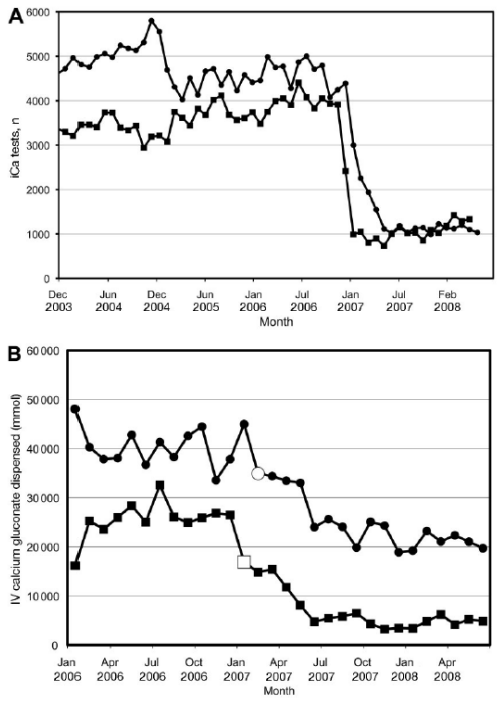



**Table 1.** Clinical outcomes before and after institution of reflexive iCa testing.[a]

| | Total discharges and deaths, n | Deaths, n | Cardiac arrests, n | Hypocalcemia, n | Tetany, n | Seizures, n |
|---|---|---|---|---|---|---|
| Before reflex test intervention | 36 453 | 1107 | 296 | 372 | 2 | 1344 |
| After reflex test intervention | 36 811 | 1120 | 307 | 185 | 1 | 691 |
| *P* | | 0.96 | 0.73 | >0.001 | 0.62 | >0.001 |

[a] See Materials and Methods for how diagnoses were tabulated from ICD-9 codes. Values represent total counts for the 12 months before intervention and the 12 most recent postintervention months. *P* values are from Fisher exact tests comparing the pre- and postintervention periods.

Reflex algorithm drove down overutilization without evidence of increased adverse events

(Baird et al 2009 *Clin Chem*)

# Right interval?

- Hours
  - Blood glucose
- Days
  - White blood cell count
- Months
  - Intact immunoglobulins, HbA1C
- Years
  - Bone density
- Lifetime
  - Constitutional genetic testing

# Right interval? (HbA1C testing for diabetic patients)

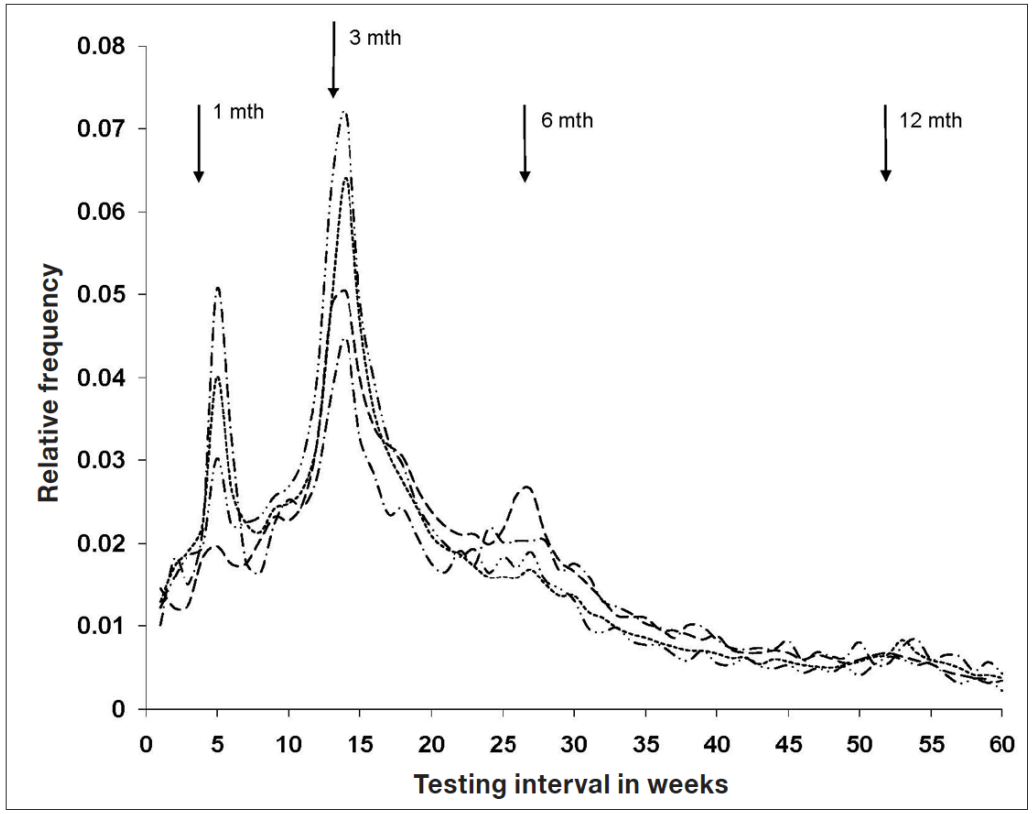



**Figure 4**. Relative frequency of HbA1c test intervals during the study period by region. •••, Calgary; – – –, Edmonton; -••-, Red Deer; -•-, Wetaskiwin.

(Lyon et al 2009 Journal of *Diabetes Science and Technology*)

# Resources for guidance on test utilization

## Choosing Wisely

https://www.choosingwisely.org/clinician-lists/

## Appropriate testing intervals

https://www.rcpath.org/uploads/assets/253e8950-3721-4aa2-8ddd4bd94f73040e/g147_national-minimum_retesting_intervals_in_pathology.pdf

## Primary Literature

https://pubmed.ncbi.nlm.nih.gov/22315270/
https://ashpublications.org/bloodadvances/article/2/22/3360/16129/American-Society-of-Hematology-2018-guidelines-for

# How to monitor test utilization?

- The process of producing a test result can involve information systems
- Monitoring this process requires a basic understanding of relevant:
    - information systems
    - data structures
    - data governance

# Different types of tests have different lifecycles

**Lifecycle of a test**

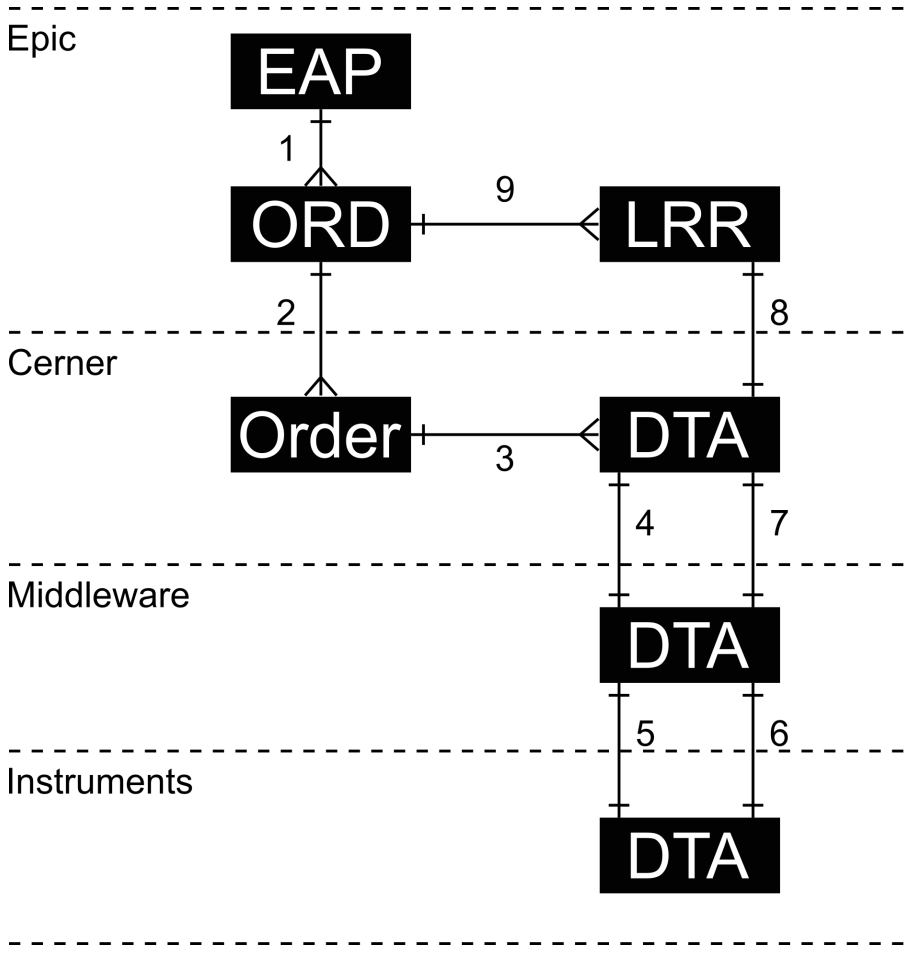
$$Order \quad \rightarrow \quad ??? \quad \rightarrow \quad Result\,in\,chart$$

- In house testing
- Interfaced sendout testing
- Noninterfaced sendout testing

# In house testing

Monitoring of lab utilization may require querying different information systems

The sendout test cycle is yet more complex



# Systems most relevant lab utilization QI projects

- Epic (EMR)
- Cerner (LIS)

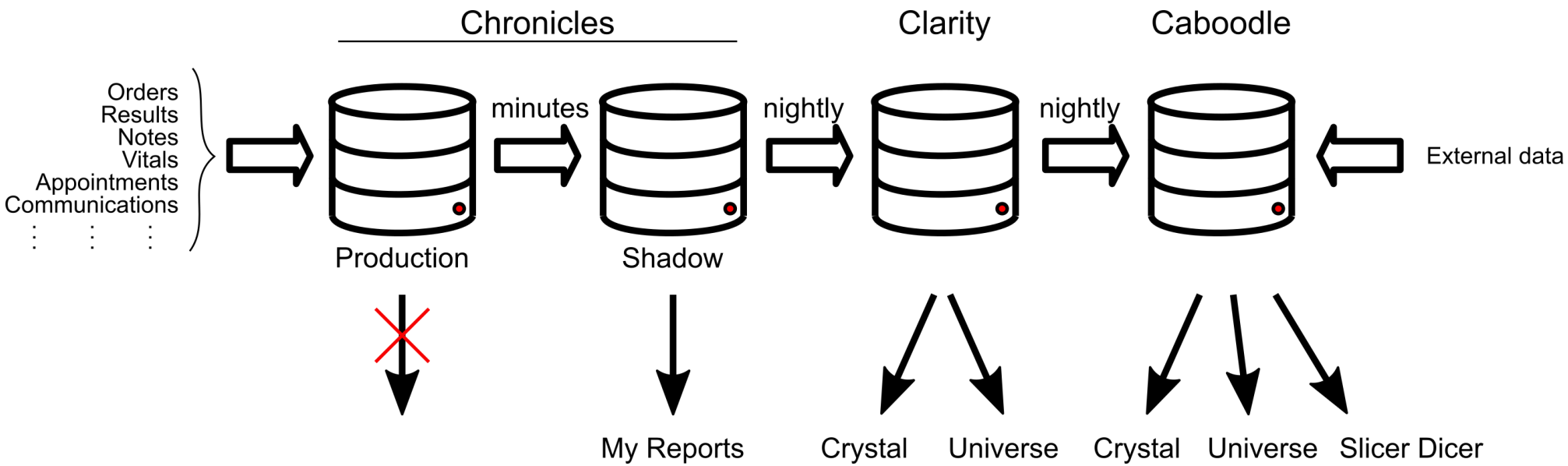
## What is in Epic

- Results
- Orders
- Notes
- Diagnoses
- A lot more

## What you might need to look for elsewhere

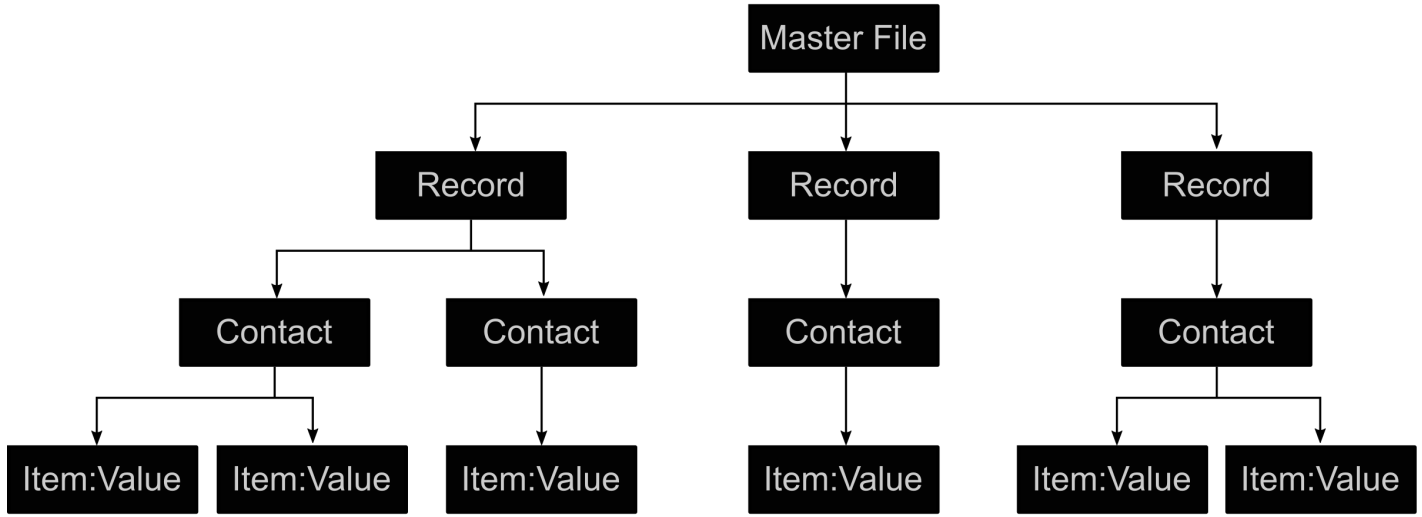
- Instrument level data
- Logs of middleware processes
- Some lab specific data

# EPIC databases and reporting




**Note**: Chronicles and clarity/caboodle have very different data models

# Chronicles data model (hierarchical)




Master File = Data Concept
(ORD = orders)

Record = Instance of Data Concept
(CBC Order on John Doe on <Date/TIme>)

Contact = Time Stamped Set of Discrete Data Elements
(Order Creation on <Date/TIme>)

Item : Value = Discrete Data Elements
(Order Creator : Debbie TheDoctor MD,
Order Released By : Steve Thenurse NP,
Hemoglobin : 14 g/dL
WBC Count : 5,000 cells/µL)

**This architecture is optimized for fast, realtime writing of new data**

# Clarity/clarity data model (relational)

| Name | Dry/Wet Food | Good Boy (Y/N) |
|---|---|---|
| Fido | Dry | Y |
| Rex | Wet | N |
| Bubbles | Dry | Y |
| Cujo | Wet | N |

| Tag # | Height (in) | Weight (lbs) |
|---|---|---|
| 1573 | 15 | 21 |
| 2684 | 9 | 7 |
| 3795 | 27 | 130 |
| 4806 | 6 | 5 |

| Tag # | Name | Breed | Color | Age |
|---|---|---|---|---|
| 1573 | Fido | Beagle | Brown/White | 1.5 |
| 2684 | Rex | Pekingese | White | 9 |
| 3795 | Bubbles | Rottweiler | Black | 5 |
| 4806 | Cujo | Chihuahua | Gold | 4 |

**This architecture is good for quickly building custom views of the database**

image credit: https://www.logianalytics.com/relational-vs-non-relational-databases/

# Where you can go for help with utilization monitoring

- Faculty mentor
- Informatics attending
- Submit a ticket to the informatics section (path.wustl.edu/informatics)

**You don't need to be a computer scientist to complete your QI project**

# Protect your data!

- You will be accessing large volumes of data protected under HIPAA
- It is your responsibility to protect these data
  - Export only what is necessary for your QI project
  - Keep all HIPAA on Wash U encrypted servers
  - Do not save patient data to a local/personal device
- Ask if you have questions regarding data security

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# Thank you!

Contact: zaydmanm@wustl.edu