National Web-Based Teleconference on Health IT and Safety

Using Health IT to Prevent Adverse Events

July 13, 2010

Moderator:

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AHRQ National Resource Center for Health Information Technology

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Mining electronic health records for patient safety research

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Meaningful Use Incentives

One Hundred Eleventh Congress
of the
United States of America

AT THE FIRST SESSION

Begun and held at the City of Washington on Tuesday, the sixth day of January, two thousand and nine

An Act

Making supplemental appropriations for job preservation and creation, infrastructure investment, energy efficiency and science, assistance to the unemployed, and State and local fiscal stabilization, for the fiscal year ending September 30, 2009, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE.

This Act may be cited as the "American Recovery and Reinvestment Act of 2009".

SEC. 2. TABLE OF CONTENTS.

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Potential US Annual EHR data

1,000,000,000	visit notes
35,000,000	admit notes, discharge sum.
46,000,000	procedure notes
3,000,000,000	prescriptions
1,000,000,000	laboratory tests
>50,000,000,000	facts

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Benefits of EHR data

- symptoms, signs, and detailed treatments
- detailed temporal course
- clinician's reasoning
- good redundancy

Much is in the narrative notes

Event detection

- Bates (JAMIA 2003) review
  - Rocha, Evans, Dessau, Pittet, … each on nosocomial infection using microbology and pharm data
  - Honignman, Brown, Classen, Payne, Jha, … each on adverse drug events using lab, pharm, admin data
  - Benson, … each on adverse events using vitals and pharm data
- Melton (JAMIA 2005) on adverse events using discharge summaries
- Handler (AMIA 2008) on adverse drug events using a clinical event monitor
- Hinrichsen (JAMIA 2007) on vaccine adverse events using alert-driven reports

Framework

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Event detection

1. Select target events
2. Analyze clinical data repository
3. Data preparation (including NLP)
4. Queries, rules
5. Verification of events
6. Classification
7. Feedback to improve queries

Target errors

- Explicit voluntary error reporting
  - —error,” —unexpected,” —inadvertent”
- Learning from reported errors
  - New York State event definitions
- Conflicts in the record
  - Evidence of errors and adverse outcomes
- Literature
  - Candidate set of events from existing literature

Data sources

- Administrative data
  - Ubiquitous, coded
  - May not reflect truth: errors, lack of temporal information, code creep, coded after discharge, adverse events poorly represented
- Laboratory, medication data
  - Direct evidence for laboratory and medication related errors
  - Indirect evidence: Medications to rescue or treat adverse events, evidence for a diagnosis
- Narrative data
  - Visit notes, discharge summary, admission notes, progress notes, operative reports, resident signout, ancillary reports
- Work flow information
  - Order entry, coded documentation
  - Opportunity for timely intervention

Terminology challenges

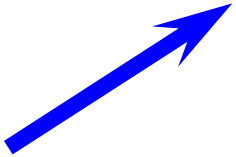
- Terminology and data model
  - Different sources use different coding
  - Cannot easily share detection rules with others
    - ICD9-CM is one exception
- Often only a limited view of the clinical state and process

Natural language processing

- Generate coded information
  - Defined structure
  - Defined vocabulary
  - Handle negation, distribute modifiers, etc.
- Keyword searching
  - Find documents with relevant words
  - Negation, ambiguous terms, spelling
  - Stemming prefixes and suffixes
  - Mapping to a thesaurus (UMLS)
  - Best for less common conditions

Deep Natural Language Processing

"Slight increase of pulmonary vascular congestion with new left pleural effusion, question mild congestive changes"



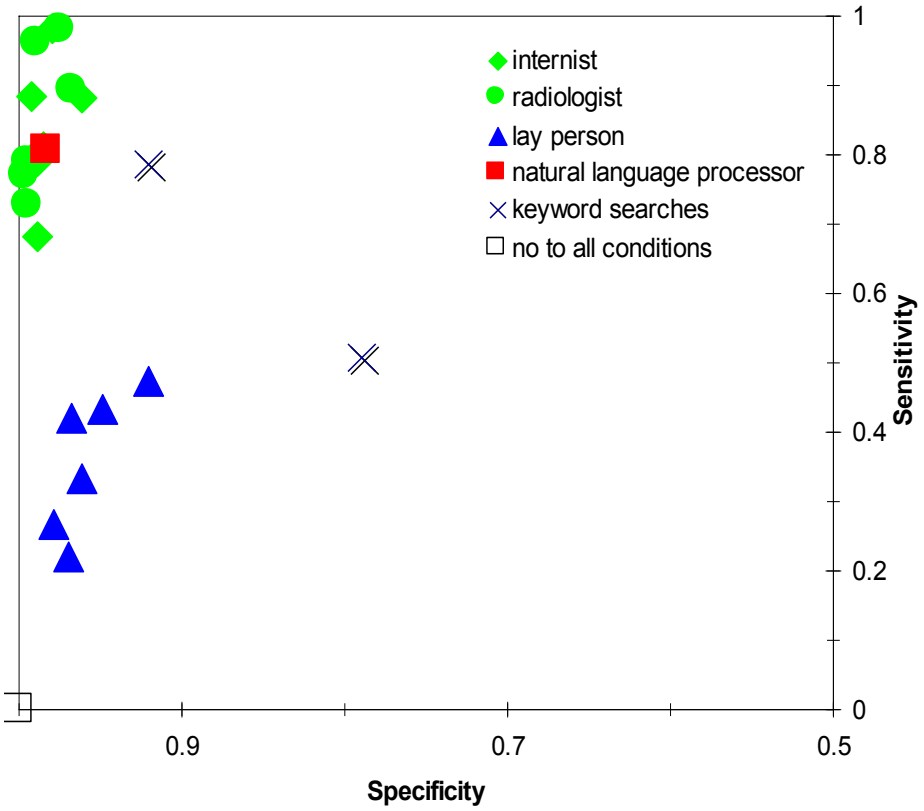
pulmonary vascular congestion
change: increase
degree: low

pleural effusion
region: left
status: new

congestive changes
certainty: moderate
degree: low

Friedman ... JAMIA 1994,2004

NLP at Columbia



Ann Intern Med 1995;122:681-8

Demography of CXRs

- 10 years; 889,921 reports; 250,000 pts.
- Side of lesions
  - Side of lung mass
    - right:left 1.49 (1.40-1.58) or 3:2
    - volume 1.14
    - weight 1.2
    - inhaled aerosol 1.28
- Bullet and stab wounds
  - Dropped 46% over 10 years
  - Consistent with FBI rates
    - violent 52%; aggravated assault 41% (NS)
    - murder 67% (p<.001)

Radiology 2002;224:157–63.

Calibration via falls

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Falls

- Calibrate database to literature
- Look for evidence of a fall
  - severe enough to warrant a radiology report
- Look for "s/p fall," …
- But not "fallopian tube," "no fall"
- Not related to the admission
  - at least two days after admission

Falls

- Results
  - 1447 inpt. visits with a fall out of 553,011
  - 2.6 per 1000
  - by age
    - 16-44 = 0.95 per 1000
    - 45-64 = 2.1 per 1000
    - 15-64 = 1.4 per 1000
    - 65+ = 6.5 per 1000
  - 0.35 per 1000 (14%) had a fracture
- Literature
  - estimate 6.6 per 1000
  - age 16-64
    - 0.1 per 1000
    - 0.19 to 0.30 per 1000
  - age 65+
    - 1 per 1000
    - 3.19 per 1000
    - 19 per 1000 (elderly)
  - 0.4 per 1000 injury

Conflicts in the EHR

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Identifying AEs using conflicts in EHR

- Increase predictive value of AE detection using NLP
- Find —conflicts"
  - e.g., mismatch between admit and discharge diagnoses
- Design
  - 150 cases from each of 5 target areas
  - 2 internal medicine reviewers

Yu A, Stetson PD, Hripcsak G. Medinfo 2004:1923

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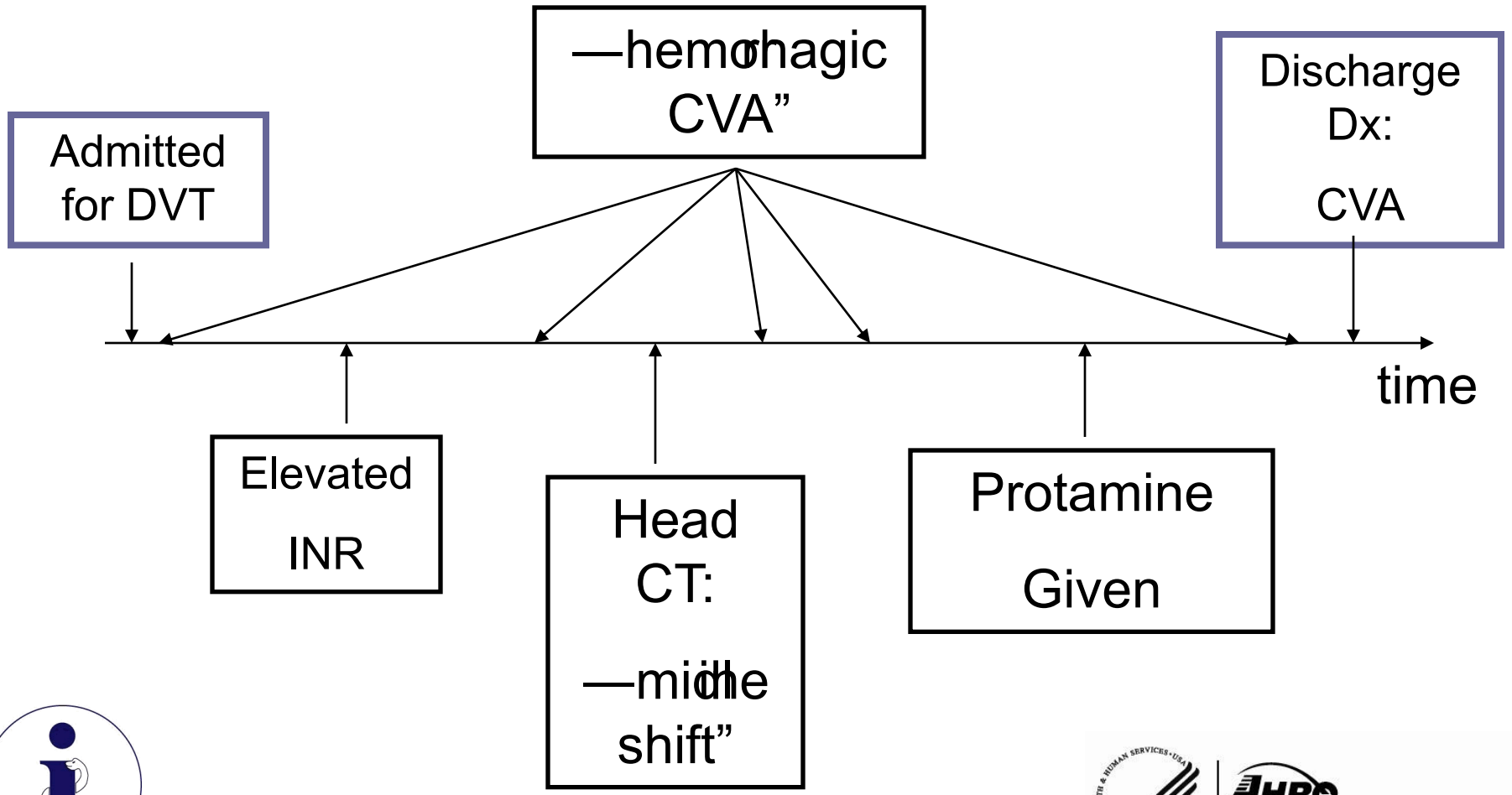
Conflicts in the EHR: —Digital clues"



Conflicts in the EHR: 1990-1999

Target	Total Cases	Matches (%)	P True Conflict	Mis-Matches (%)	P True Conflict†
MI	7901	5850 (74)	0.012	2051 (26)	0.18
Stroke	11356	8270 (73)	0.014	3086 (27)	0.16
Aspiration Pneumonia	4615	701 (15)	0.0625	3914 (85)	0.18
PE	1923	486 (25)	0.0	1437 (75)	0.39
Catheter – related Infections	2138	436 (20)	0.0	1702 (80)	0.25

†Estimated from manual review of random subset (~150 cases for each diagnosis)

Self reporting in the EHR

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Self reporting in the EHR

- Do clinicians report errors in the record?
- Narrative
  - discharge summary
  - outpatient notes
  - signout notes

Cao H, Stetson P, Hripcsak G. J Biomed Inform 2003;36:99-105.

Self reporting in the EHR

- Accident
- Active Error
- Adverse
- Adverse Drug Event
- Adverse Drug Reaction
- Adverse Event
- Adverse Medical Event
- Adverse Outcome
- Allergic Reaction
- Bad Outcome
- Complication
- Diagnostic Error
- Drug Toxicity
- Error
- Error of Comission
- Error of Omission
- Harm
- Human Error
- Iatrogenic
- Iatrogenic Injury
- …

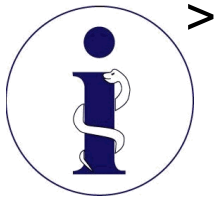
Self reporting in the EHR

- He did not take the antibiotics because I mistakenly prescribed augmentin when he has a penicillin allergy. Luckily, his pharmacist caught the error.
  - (near miss)
- It was noted that pt had been given albuterol inhaler instead of vancenase for intranasal use! pt alerted to mistake made by pharmacy

Self reporting in the EHR: PPV

	Discharge sum	Signout note	Visit note
Mistake	10%	36%	16%
Error	3%	11%	1%
Inadvertent	24%	20%	22%
Incorrect	12%	0%	0%
Iatrogenic	14%	20%	
Total	8%	15%	5%

Discharge sum hospital course section PPV 15%
>1000 actual instances of error in ten years



Self reporting in the EHR

Physicians	36%
Nurses	14%
Pharmacy	8%
Radiologists	4%
Administration	3%
Unknown	34%

Inside institution	81%
- self	4%
- others	39%
- unknown	57%
Outside institution	12%
Unknown	6%

With adverse outcome	41%
Without adverse outcome	58%
Near miss with recovery	1%

Large scale event reporting

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New York State events

- 45 events defined by New York State
  - hemorrhage during procedure
  - new DVT
  - post-op infection
  - pulmonary edema related to volume overload
  - new pulmonary ebolism
  - equipment malfunction with serious injury
  - etc.

Melton GB, Hripcsak G. J Am Med Inform Assoc 2005;12:448-57

Event reporting

- Use NLP and 45 rules to detect errors in discharge summaries
- Review 1000 randomly chosen charts
- Review all 1461 positives detected from 57,452 DSUMs

Event reporting

- By case
  - prevalence .053
  - manual review sensitivity .09

Sensitivity	.28 (.17-.42)
Specificity	.985 (.984-.986)
Positive predictive value	.45 (.42-.47)
Negative predictive value	.96 (.95-.97)

- By event type

Sensitivity	.25 (.15-.37)
Specificity	.9996 (.9996-.9997)
Positive predictive value	.44 (.42-.47)
Negative predictive value	.9989 (.9986-.9992)

Next-generation detection

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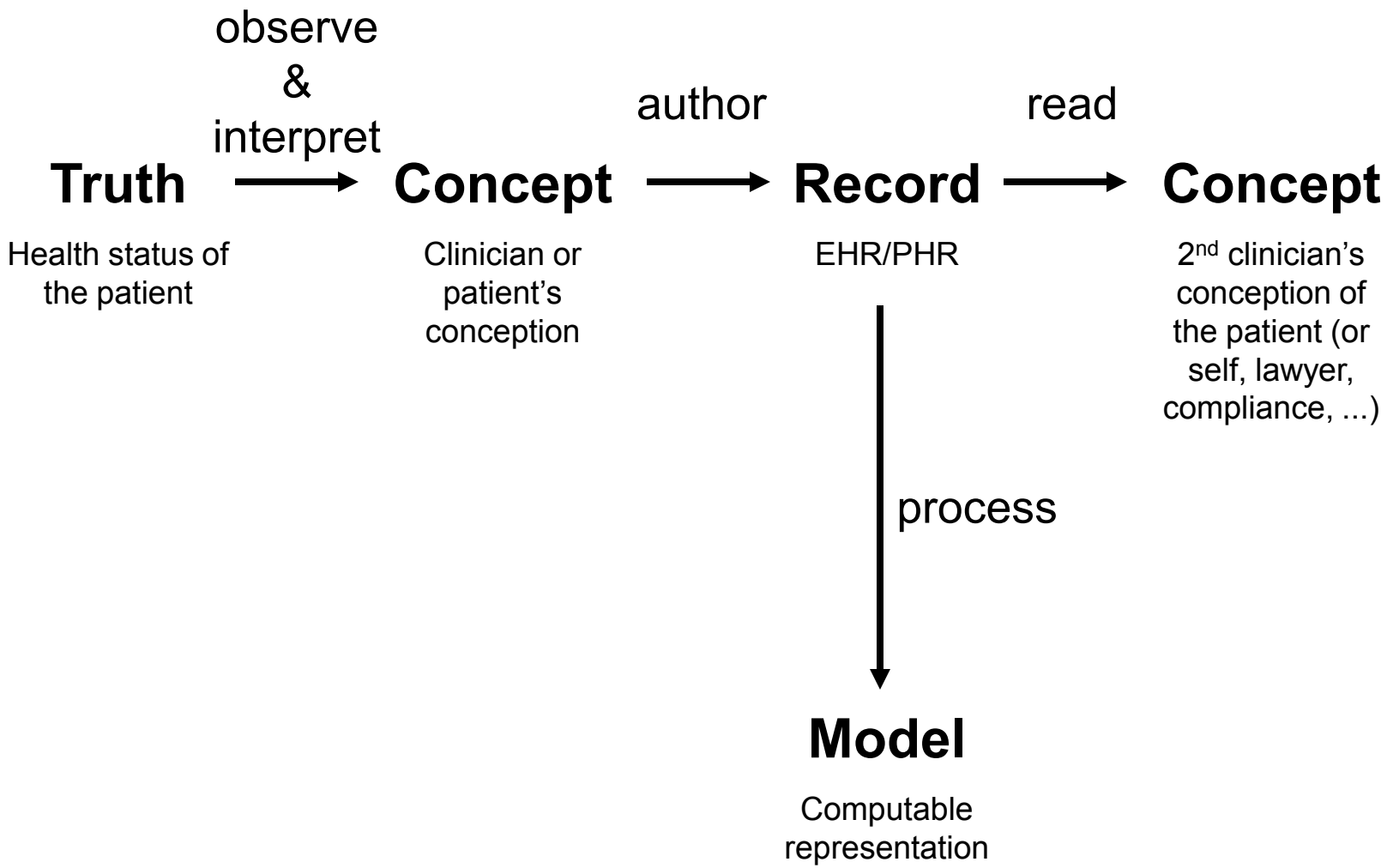
Challenges

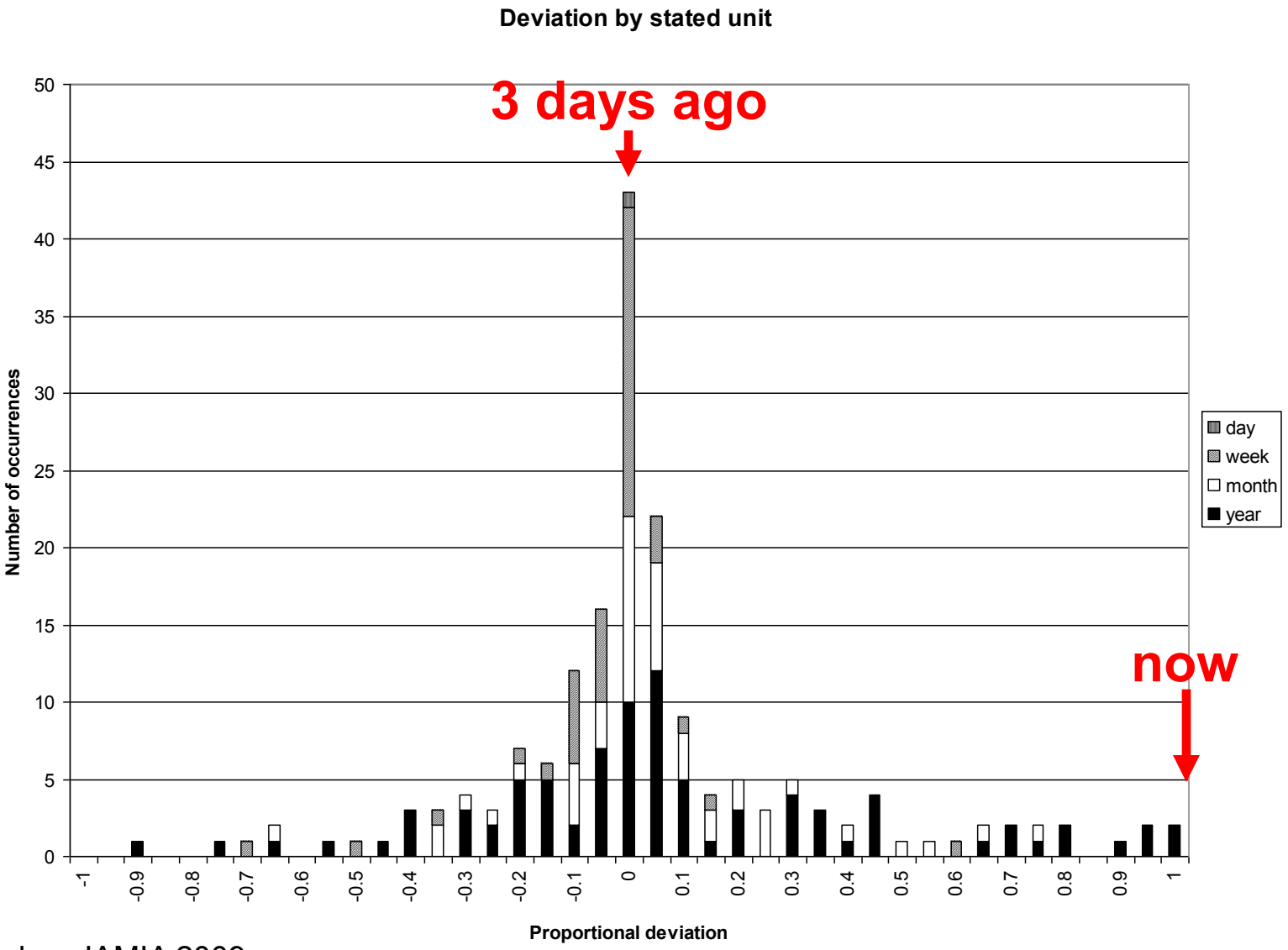
- Solvable
  - Lack of penetration of EHRs
  - Distributed systems
  - Inconsistent formats
  - Privacy
- Hard
  - Quality of data
    - accuracy, completeness, complexity
  - Bias

Data quality

- All medical record information should be regarded as suspect; much of it is fiction.
  - Burnum JF ... Ann Intern Med 1989



Learning from the Data



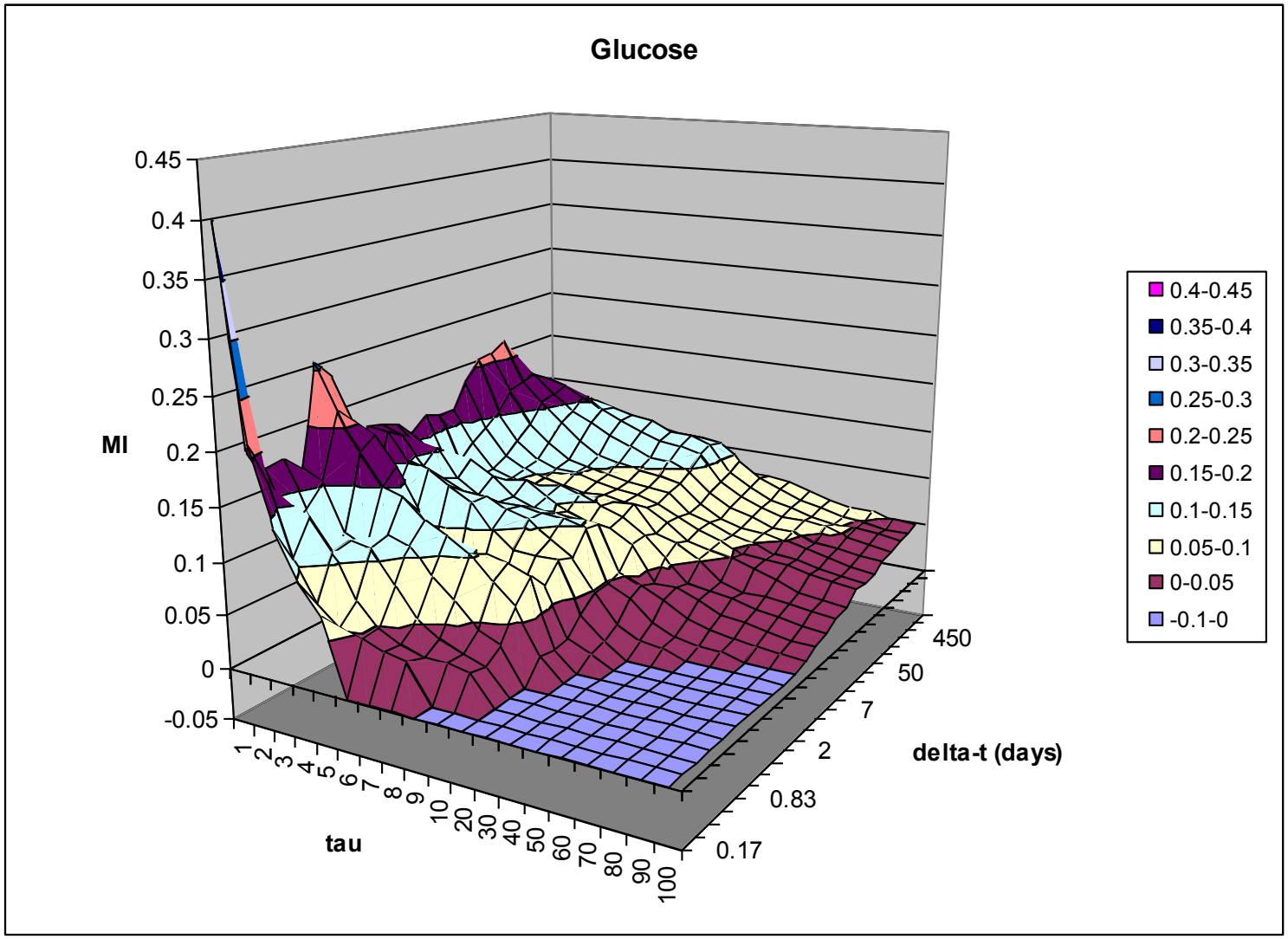
Hripcsak ... JAMIA 2009

Physics of medical records

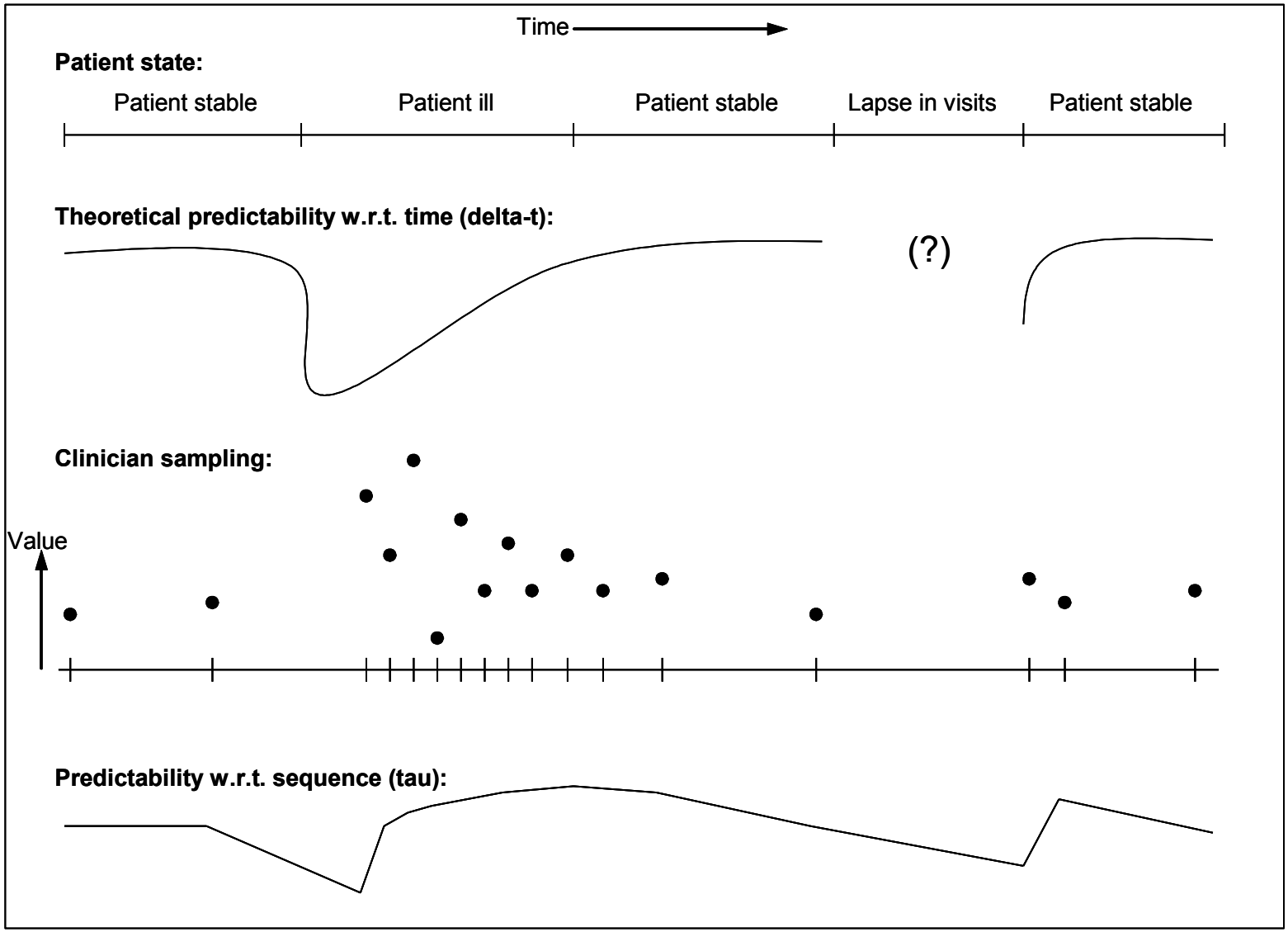
- Study the EHR as an object of interest in itself
  - the EHR as a natural system
  - understand and correct for or avoid biases
- Apply methods from nonlinear time series analysis

$$I(X;Y) = \mathbb{E}_{X,Y}[SI(x,y)] = \sum_{x,y} p(x,y) \log \frac{p(x,y)}{p(x)\,p(y)}$$

New Information Tools



Illness, sampling & predictability



Conclusions

Conclusions

- EHR can be useful in patient safety research
  - you need an EHR
- Imperfect sources and imperfect processing
  - reports collected for different purposes, although redundancy helps
  - complex reports (DSUM) require complex processing (NLP)
  - can exploit simpler keyword techniques effectively
- Performance depends mainly on what is available in the clinical repository

Thank You!

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Bar-coding and Medication Safety

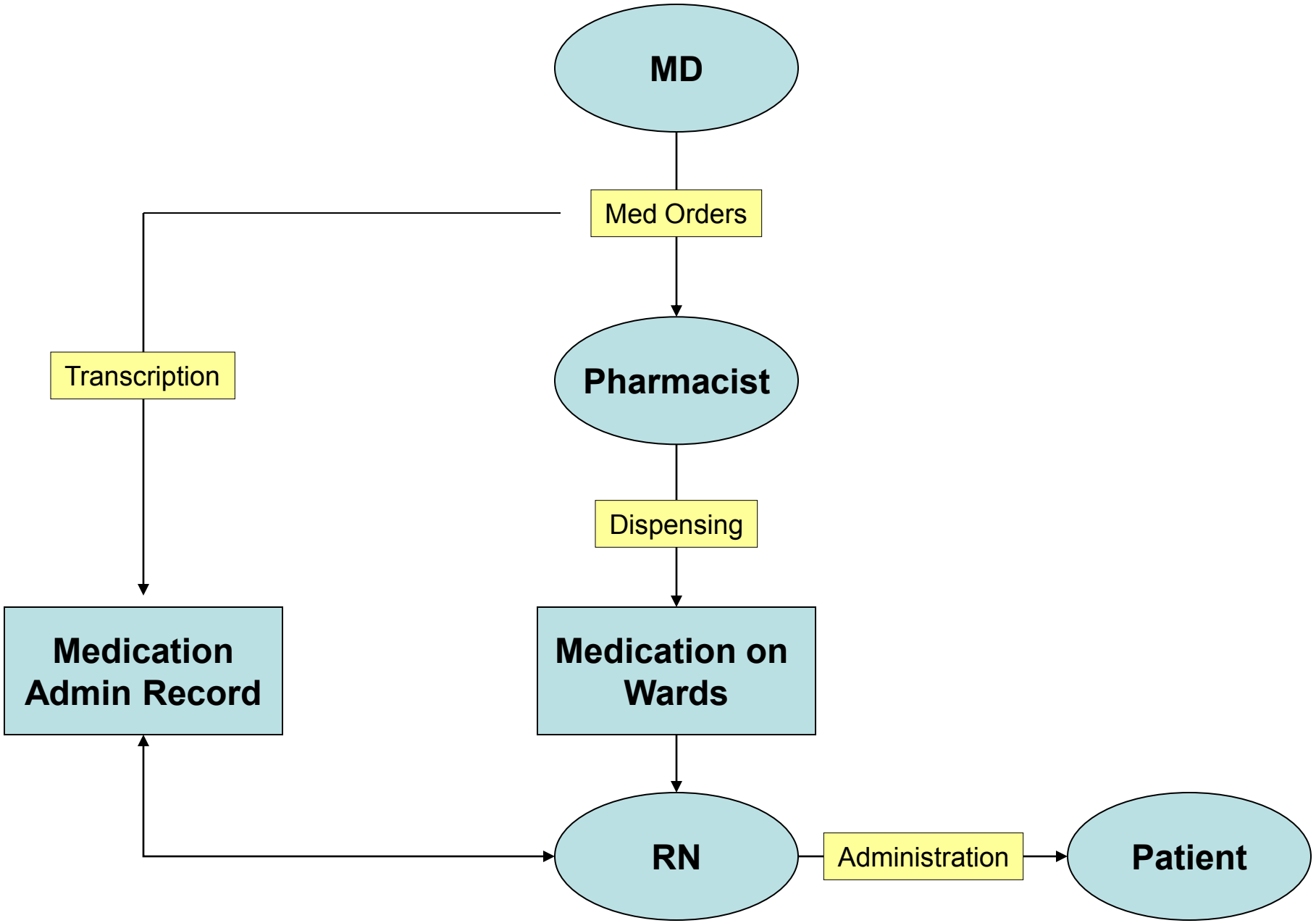
Tejal Gandhi, MD, MPH

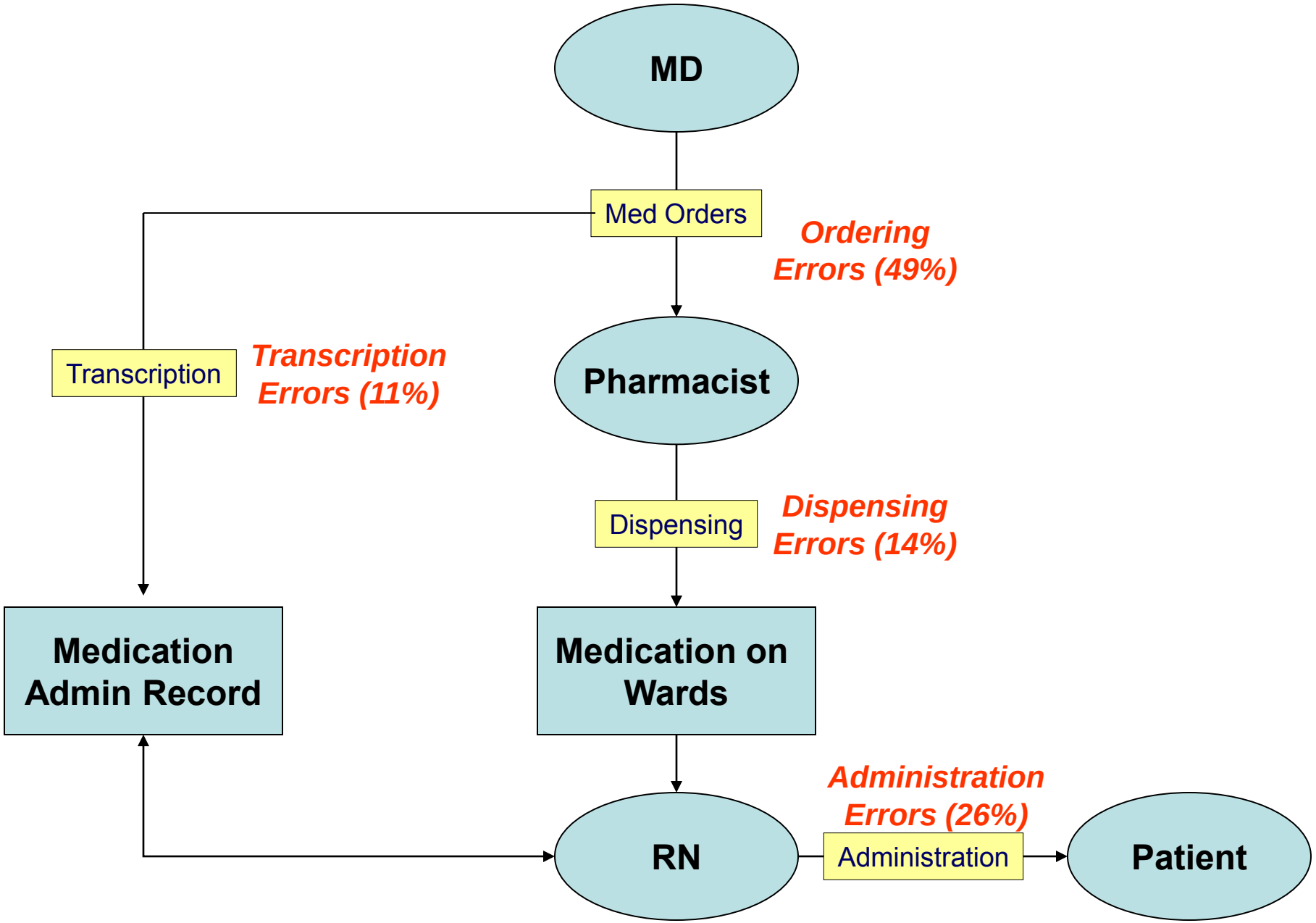
Director of Patient Safety
Partners Healthcare
Associate Professor of Medicine
Harvard Medical School

Funded by a grant from AHRQ

Medication Safety

- The typical hospital medication process has multiple stages:
  - Ordering--MD orders medication
  - Transcribing--nurse copies order onto a paper medication administration record (MAR)
  - Dispensing--pharmacy sends medication to the floor
  - Administering--nurse gives medication to patient and documents this on the MAR
  - Monitoring—assessing whether or not the patient had an adverse effect
- Medication errors in hospitals are common and can have serious consequences
  - Errors can occur at any stage


MD
Med Orders
Transcription
Pharmacist
Dispensing
Medication Admin Record
Medication on Wards
RN
Administration
Patient


MD
Med Orders
Ordering Errors (49%)
Transcription
Transcription Errors (11%)
Pharmacist
Dispensing
Dispensing Errors (14%)
Medication Admin Record
Medication on Wards
Administration Errors (26%)
RN
Administration
Patient

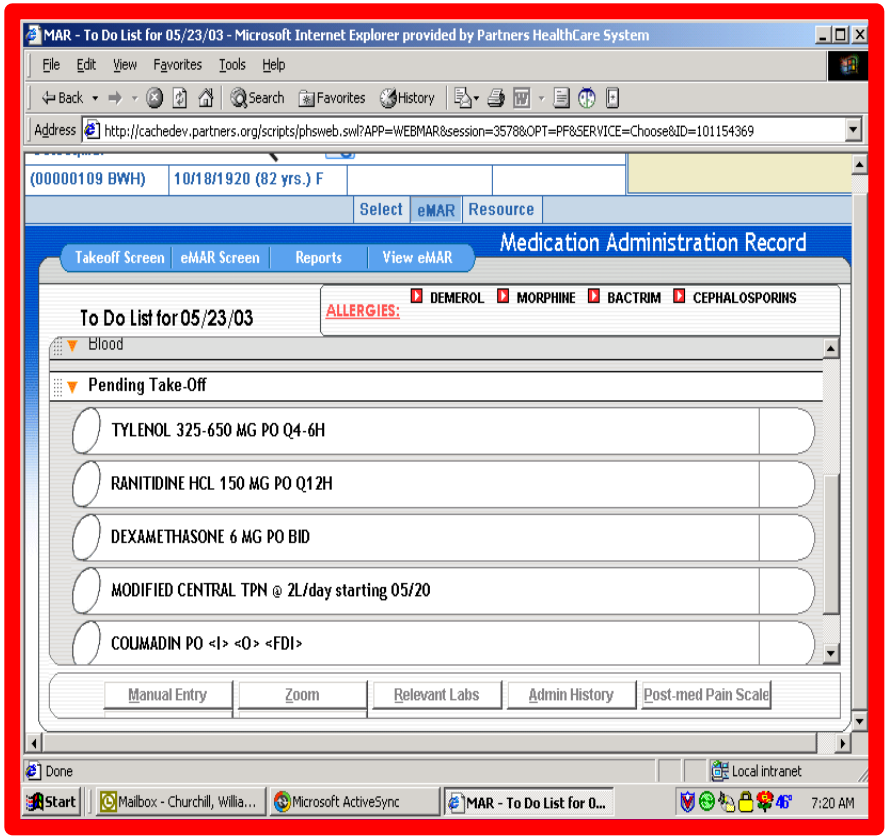
IT Solutions by Stage

- Ordering errors
  - Computerized physician order entry (CPOE)
- Transcription errors
  - Electronic medication administration records (eMAR)
- Dispensing errors
  - Bar-coding
  - Robots
- Administration errors
  - Bar-coding
  - Electronic medication administration records (eMAR)
  - Smart pumps

Barcode/eMAR at the Bedside

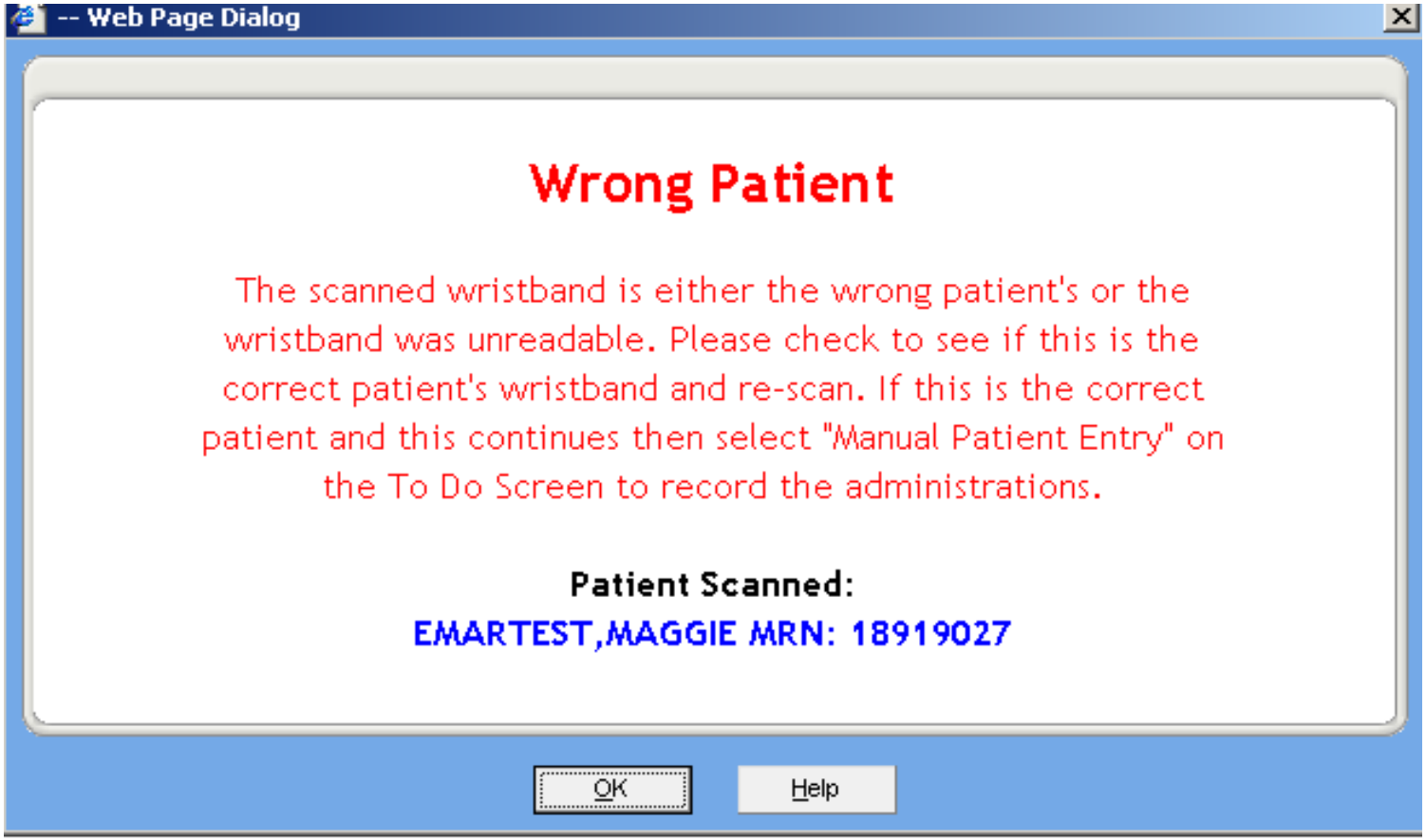
- Orders flow electronically from CPOE to an electronic medication administration record (eMAR)
  - Eliminates transcription entirely
  - Nurses have laptops with eMAR and use this to track what medications need to be given (administered)
- Nurses use barcode scanning of the medication and the patient to verify that the drug they are administering matches the physicians' orders
  - Right drug, right patient, right dose, right time
  - eMAR alerts if any of these is incorrect
  - Potentially reduces administration errors

Barcode Medication Scanning at the Bedside: Components that make it work



Real Time Alerts to Nurse

Real Time Alerts to Nurse



Evaluating the Impact of Barcode-eMAR on medication Administration Errors

- Study Design
  - Non-randomized, controlled observational study comparing error rates on units with and without bedside barcode scanning
- Primary Study Outcomes
  - Directly-observed *medication administration errors*
  - Directly-observed *potential adverse drug events* (ADEs) due to medication administration errors
- Data Collection
  - Direct observations of medication administrations by trained research nurses
  - All errors detected adjudicated by 2 members of a multi-disciplinary panel

Impact of Barcode Scanning Technology on Administration Errors and Potential Adverse Drug Events

	No Barcode Scanning (n=6712)	Barcode Scanning (n=7314)	Relative Reduction (p-value)
Medication Administration Errors	11.5%	6.8%	41% (p<0.001)
Potential Adverse Drug Events	3.1%	1.6%	50.8% (p<0.001)

Poon et al, NEJM 2010

Impact on Potential Adverse Drug Events of Various Severity

	No Barcode Scanning (n=6712)	Barcode Scanning (n=7314)	Relative Reduction (p-value)
Potential Adverse Drug Events	3.1%	1.6%	51% (p<0.001)
Significant	1.82%	0.94%	48% (p<0.001)
Serious	1.30%	0.60%	54% (p<0.001)
Life-threatening	0.03%	0.01%	54% (p=0.52)

Poon et al, NEJM 2010

Impact of Barcode eMAR on transcription errors

	Manual Transcription (n=1799)	Automatic Transcription (n=1283)	Relative Reduction (p-value)
Transcription Errors	6.1%	0%	100% (p<0.001)
Potential Adverse Drug Events due to transcription Errors	3.0%	0%	100% (p<0.001)
Significant	1.6%	0%	100%
Serious	1.3%	0%	100%
Life Threatening	0.06%	0%	100%

Poon et al, NEJM 2010

Admin and Transcription Error Study - Conclusions

- Barcode scanning technology can significantly reduce the incidence of medication administration and transcription errors and associated potential adverse drug events
- Significant impact on medication safety at study hospital
  - ~90,000 potential ADEs prevented per year during administration stage
  - ~50,000 potential ADEs prevented per year during transcription stage
- Errors not completely eliminated
  - Still on learning curve at time of study
  - Possibility of new errors being introduced
  - Incomplete compliance with scanning
  - Need for ongoing monitoring and improvements

Impact of eMAR on Nurse Satisfaction

- Pre and post surveys
- Main Results: Nurses feel medication administration is safer and more efficient after implementation of barcode technology

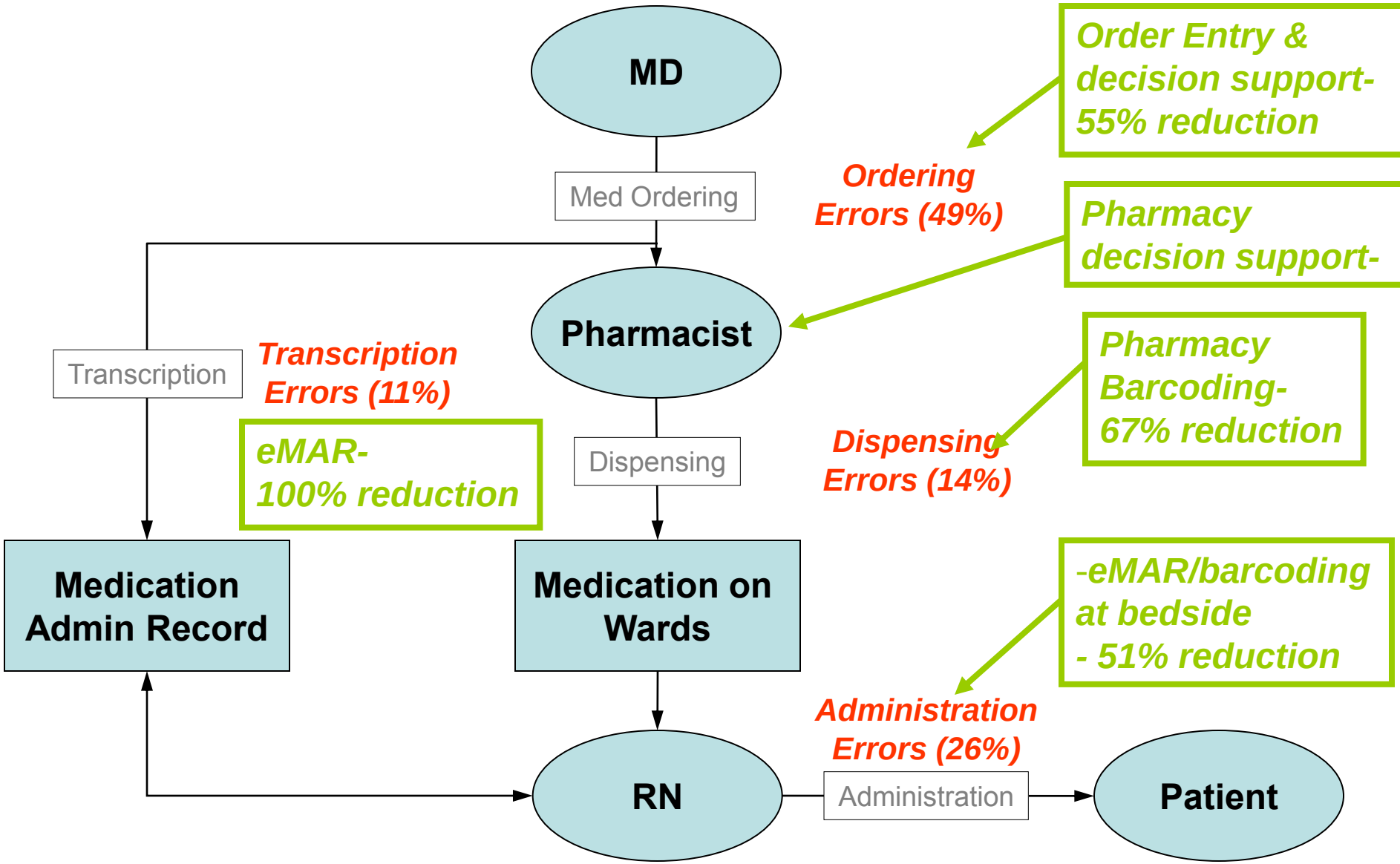
Hurley, A et al. Journal of Nursing Administration 2007

Impact on Nurse Workflow

- 232 2-hour observation sessions before and after barcode/eMAR implementation
- Primary Result: Proportion of time spent on medication administration did not change after barcode/eMAR implementation
- Secondary Result: Proportion of time spent in presence of patient increased

Keohane C, et al. Journal of Nursing Administration Dec 2008

Summary: Impact on Serious Medication Errors



Implementation Factors

- Software developed by Partner's Healthcare Information Systems analysts
  - Customized to BWH medication administration with ability to provide real time enhancements
  - Networked with existing CPOE and Pharmacy systems
  - 10 year project

Implementation

- Initial Trial March 2004
- Intermediate Care Unit and Neuro ICU for 2 weeks each
- Supports
  - Computer based training
  - 4 hour Class
  - RN Super User
  - IS Analysts

Implementation

- 45 Enhancements to software prior to incremental hospital wide roll out
- 3 Mother Baby Units
- 27 Intermediate Care Units
- 8 ICU's
- Second Phase
  - 8 Hematology Oncology Units
- Planned
  - Specialty Units – L&D, PACU, OR, ED

Super User

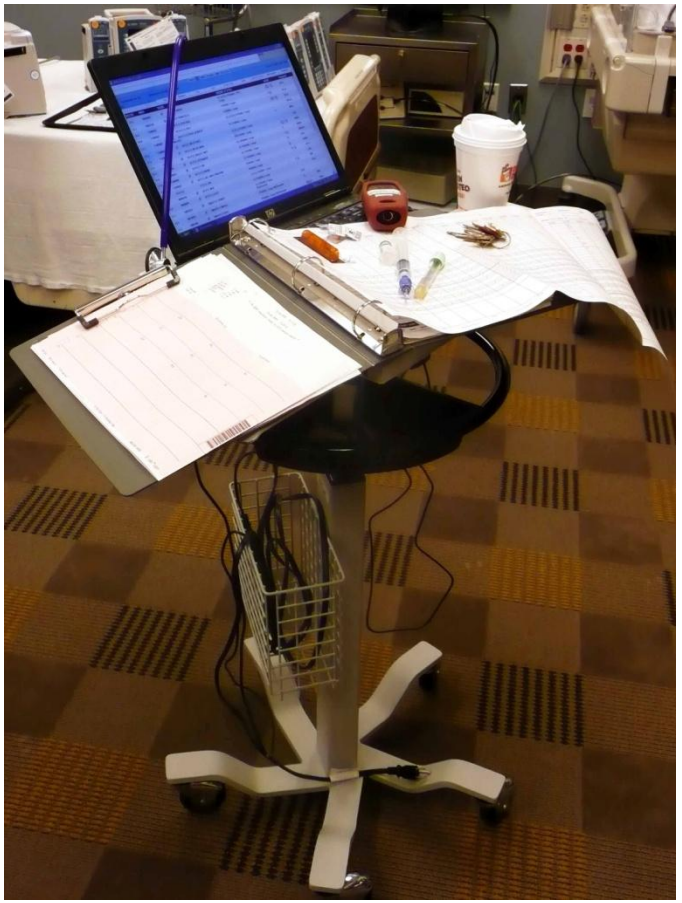
- Available to all staff nurses to assist with medication administration until proficient.

Information System Analyst

- Trouble shoots issues with the application and hardware and acts as a resource for the super users.

Hardware

- Small footprint required
- eMAR cart = Workbench
- No writing surface
- Beverages and computers don't mix well!



Scanners

- Need scanning flexibility at bedside
- Pros
  - **Fit work flow**
  - **Light, easy to use**
  - **Allowed proximity to patient**
- Cons
  - **Can lay down anywhere**
  - **Can drop anywhere**
  - **Storage location not used**

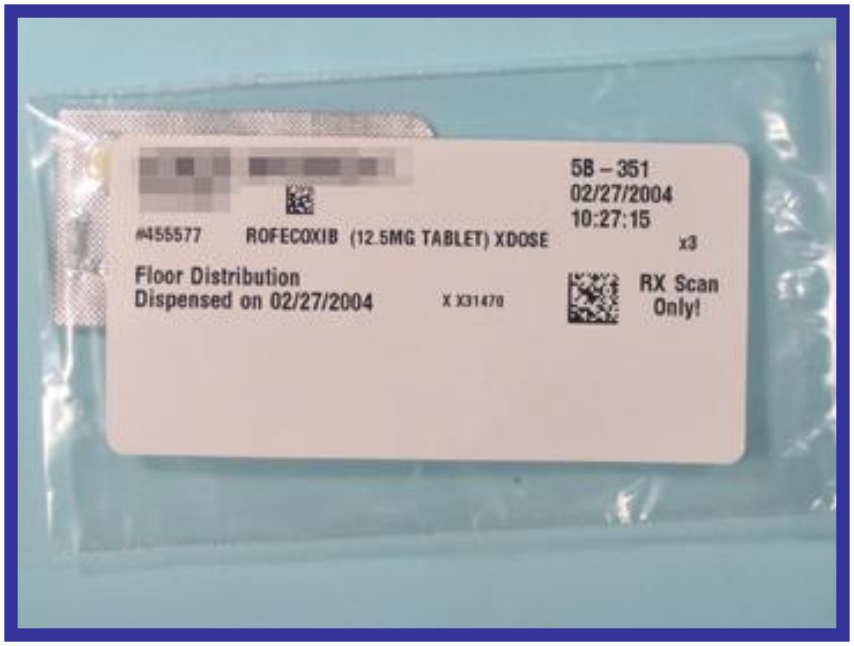
What Have We Discovered?

Bar Coding Inconsistencies

- *Where is it ?*
- *Which one do I scan ?*
- *Why won't it scan ?*

Bar Code Solutions

- Data base management
- Display of bar codes



Physician Workflow

- Inability to quickly assess medication administration data

Solutions

- Dedicated devices for physicians
- Different hardware solutions for different disciplines
- Improve log-on time
- Create user friendly screens

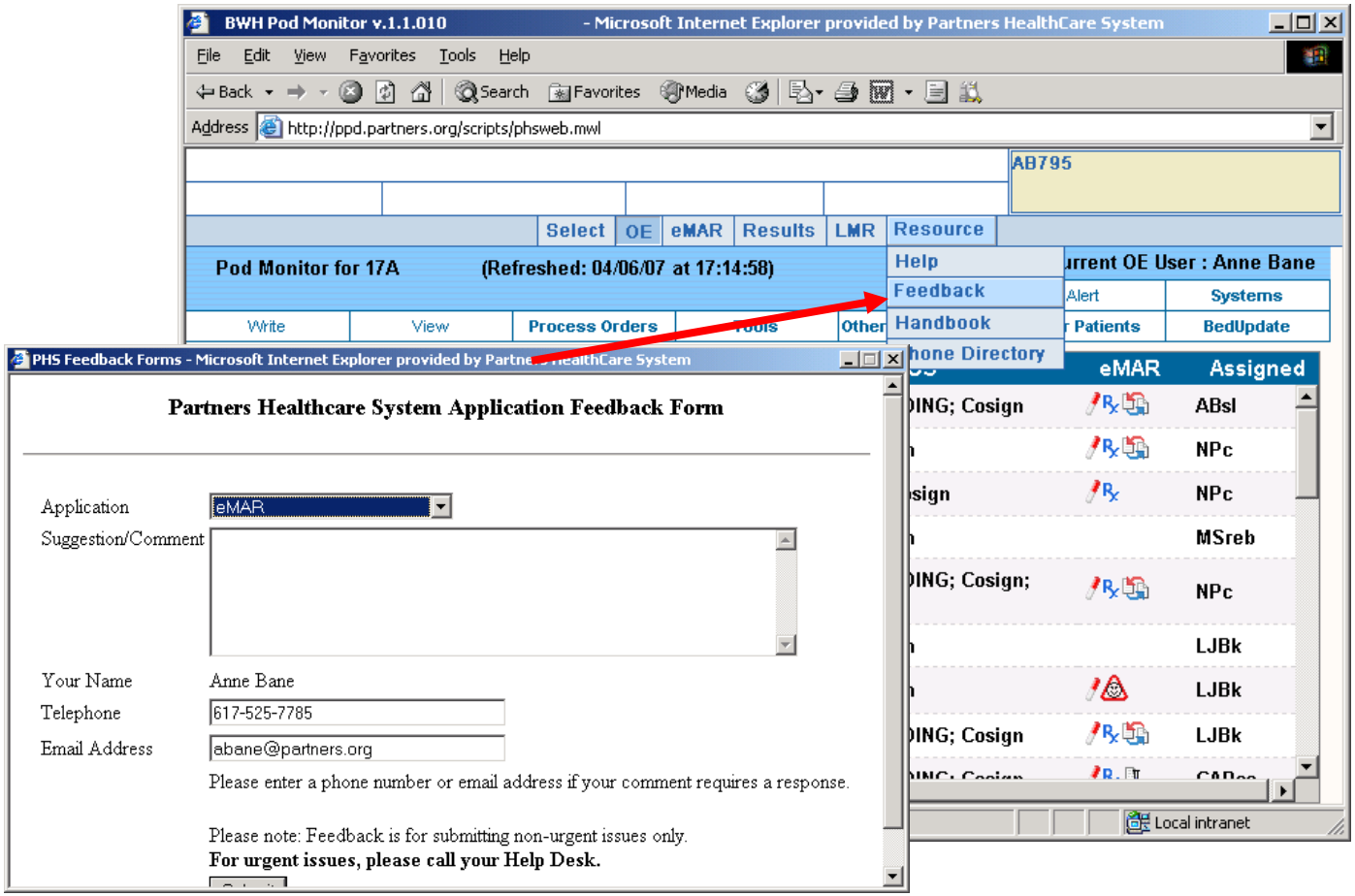
Over Reliance

- Technology driving the work flow
  - —The computer told me to give the med”
  - —The scanner beeped - it must be the right patient”
  - —The eMAR set me up to make the mistake”
- Replaces critical thinking skills
- Expect application & equipment to be perfect
- Weakening vigilance

Technology is a Tool

- Emphasize technology intended to double-check the clinician
- Review safety data regularly
- Share stories with clinicians
- Avoid over engineering functionality
  - Keep it Simple
  - Make it Easy to Do the Right Thing
- Continually seek user feedback for improvements
  - Electronic
  - Face-to-face

Continued Feedback



eMAR Lessons Learned

- Training is most successful when clinicians teach clinicians.
- Expect extreme variances in staff acceptance.
- Be ready to uncover unknown processes that have been supporting the existing MAS now.
- End user feedback is essential to design, implement and maintain technology
- Technology can never replace the critical thinking of clinicians

In Summary

- Barcode technology significantly reduces transcription and administration errors
- A well-designed and fully-supported system did not increase the proportion of time nurses spend on medication administration
- Nurses using the system had higher satisfaction with the medication process
- Key is involvement of end users from the beginning in design, hardware selection, and piloting

Thank You!

Improving The Safety of Pediatric ePrescribing

Kevin B. Johnson, MD, MS

Professor Biomedical Informatics

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Showing Your Work e-prescribing annotations project

Funded by AHRQ R03 HS016261-01

J Biomed Inform. 2010 Apr;43(2):321-5.

Show Your Work- The Problem

- Adverse events are often mitigated by pharmacists (Cotter, BMJ, 1995)
- Callbacks are the primary mechanism of communication (Isetts, Arch Intern Med 2003)
- E-prescribing provides cognitive support to prescribers, but this process and resulting decisions are not communicated to pharmacists.

Show Your Work - Hypothesis

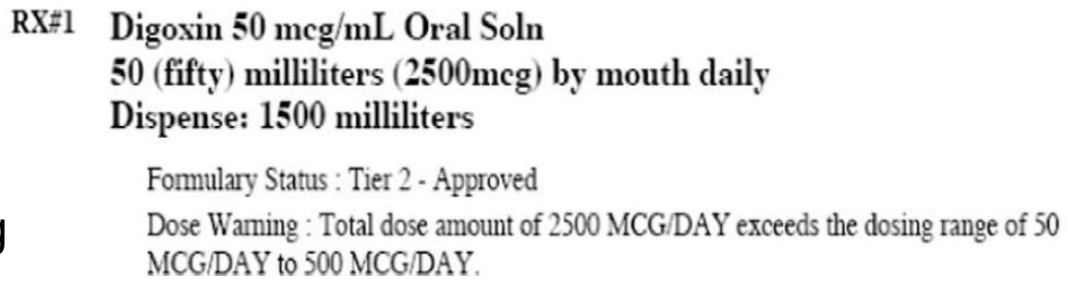
The use of a method to automatically annotate prescriptions may improve communication and reduce the risk of adverse drug events.

Show Your Work

- Single site study using internally-developed e-prescribing system (RxStar)

- Randomized trial examining callbacks in three local pharmacies
  - Reason for callback
  - Date and time
  - Type of prescription generating callback

- 7 –item survey distributed to 50 high volume local pharmacies:
  - Likert questions about impact of SYW
  - Free text explanations



RX#1 **Digoxin 50 mcg/mL Oral Soln**
50 (fifty) milliliters (2500mcg) by mouth daily
Dispense: 1500 milliliters

Formulary Status : Tier 2 - Approved

Dose Warning : Total dose amount of 2500 MCG/DAY exceeds the dosing range of 50 MCG/DAY to 500 MCG/DAY.

Fig. 1. Example of Show Your Work annotations below an electronically generated prescription.

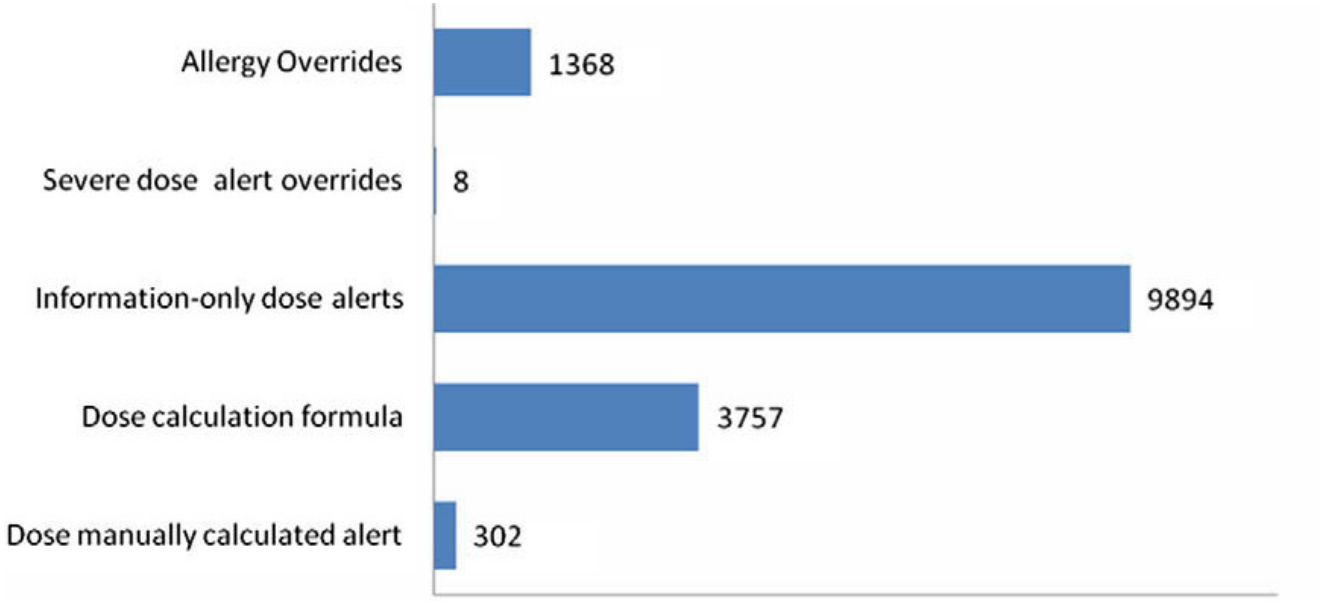
Show Your Work Results

No impact on volume of callbacks

Table 4
Callback reasons with and without Show Your Work on.

Callback reason	SYW off (%)	SYW on (%)
Error-related	19 (55.9)	20 (60.6)
Insurance	12 (35.4)	11 (33.3)
Stock issue	2 (5.8)	0 (0.0)
Rule violations	1 (2.9)	2 (6.1)
Total	34 (100)	33 (100)

Chi-sq(4) = 2.388, $p = 0.665$ (Fisher's exact test, $p \approx 1$).



SYW Pharmacist Perceptions

Table 5
Show Your Work pharmacists perception survey results ($n = 33$).

SYW...	Strongly disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly agree (%)
1. Helped me avoid callbacks	0	1 (3.0)	9 (27)	16 (48)	7 (21)
2. Helped me check for potential errors	0	0	4 (13)	20 (63)	8 (25)
3. Caused me to call the prescriber back	1 (3)	20 (61)	9 (27)	2 (6)	1 (3)
4. Was helpful in pediatric cases	1 (3)	0	5 (16)	18 (55)	9 (27)
5. Was helpful with insurance eligibility	2 (7)	10 (31)	13 (41)	5 (17)	2 (6)
6. Was helpful with avoiding callbacks due to patient-reported allergies	0	3 (9)	7 (21)	17 (52)	6 (18)
7. Was helpful avoiding callbacks due to low or high doses	0	1 (3)	10 (32)	18(55)	4 (12)

Table 6
Show Your Work pharmacists perception survey comment themes.

Theme	No. of comments
Improving communication between prescribers and dispensers	8
Decreases callbacks in some cases	3
Pediatric dosing information helps check for potential errors	16
Increases callbacks in some cases	2
Need more information to be included in annotations	2
New Show Your Work feature request	5

Show Your Work--Impact

- No change in volume of callbacks
- Comments suggest some impact on the reasons for callbacks and the quality of the callbacks.
- Structured sig/ e-prescribing should support note fields that can be used to expose results of clinical decision-support.
- Additional studies should more carefully examine quantity and quality of pharmacist communication resulting from e-prescribing.

TEPStools
Safety Through Enhanced e-Prescribing

pediatric dose rounding and compounding

Funded by AHRQ R 18 HSO17216

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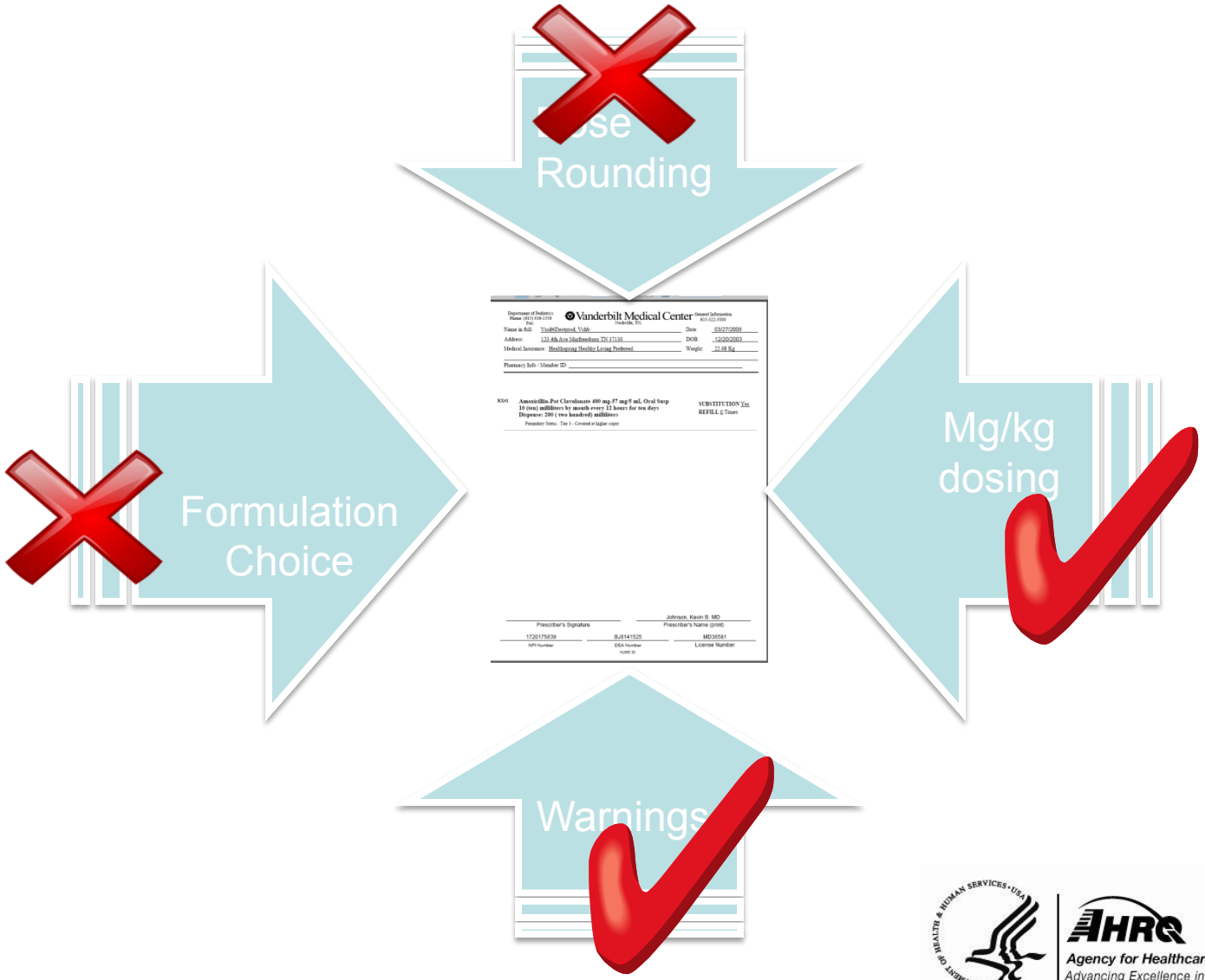
Components of Safe e-Prescribing



Ramifications

- Mismatches between formulation recommended by e-prescribing tools and what should be prescribed
- Incorrect dosing recommendations that must be overridden in e-prescribing situations.

Killelea B. Pediatrics 2007
Johnson KB, Pediatrics 1996

The Problem

Data needed to improve pediatric e-prescribing do not exist in a form that is usable by the pharmacists and vendors. How can we construct and disseminate this knowledge nationally?

STEPSTools?

Goal – to improve the safety and usability of e-prescribing in pediatrics

- Develop a knowledgebase of rounding tolerances for commonly-prescribed medications
- Develop an algorithm to round computer-calculated medication doses safely.
- Develop tools using this knowledgebase and algorithm that can be integrated into disparate e-prescribing systems
- Evaluate the impact on dosing acceptability and pharmacy callbacks

Methods

- Literature review
- Prescriber interviews
- Advisory group survey

Rounding algorithm and philosophies

- Literature review
- Drug rounding category (digoxin vs. amoxicillin?)
- Knowledge validation-SWAG

Rounding tolerance knowledgebase

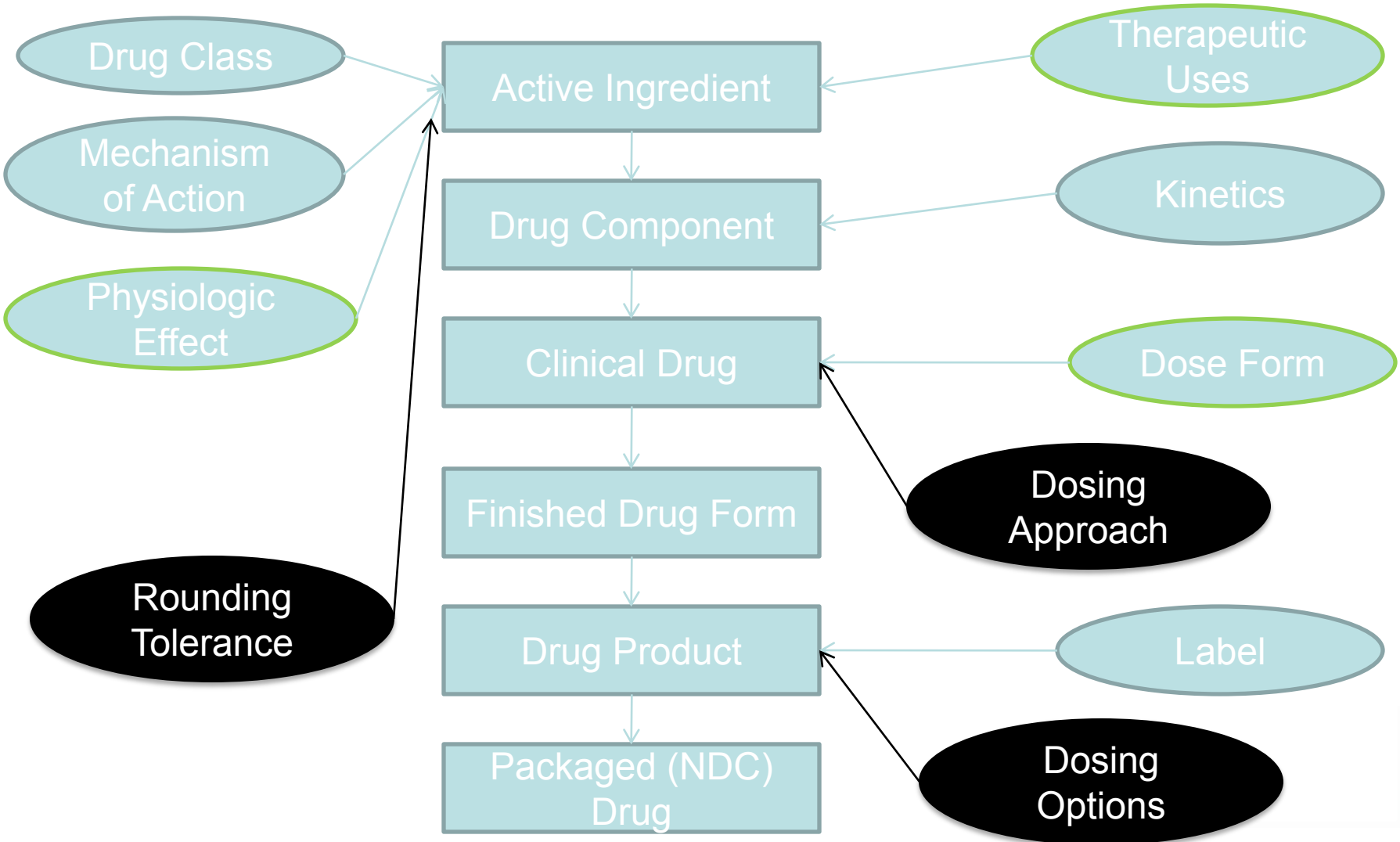
Data Collection/ Literature Review

- Discovered 115 medications to round, representing 90% of the most commonly prescribed pediatric drugs at Vanderbilt, Cincinnati, CHOP.

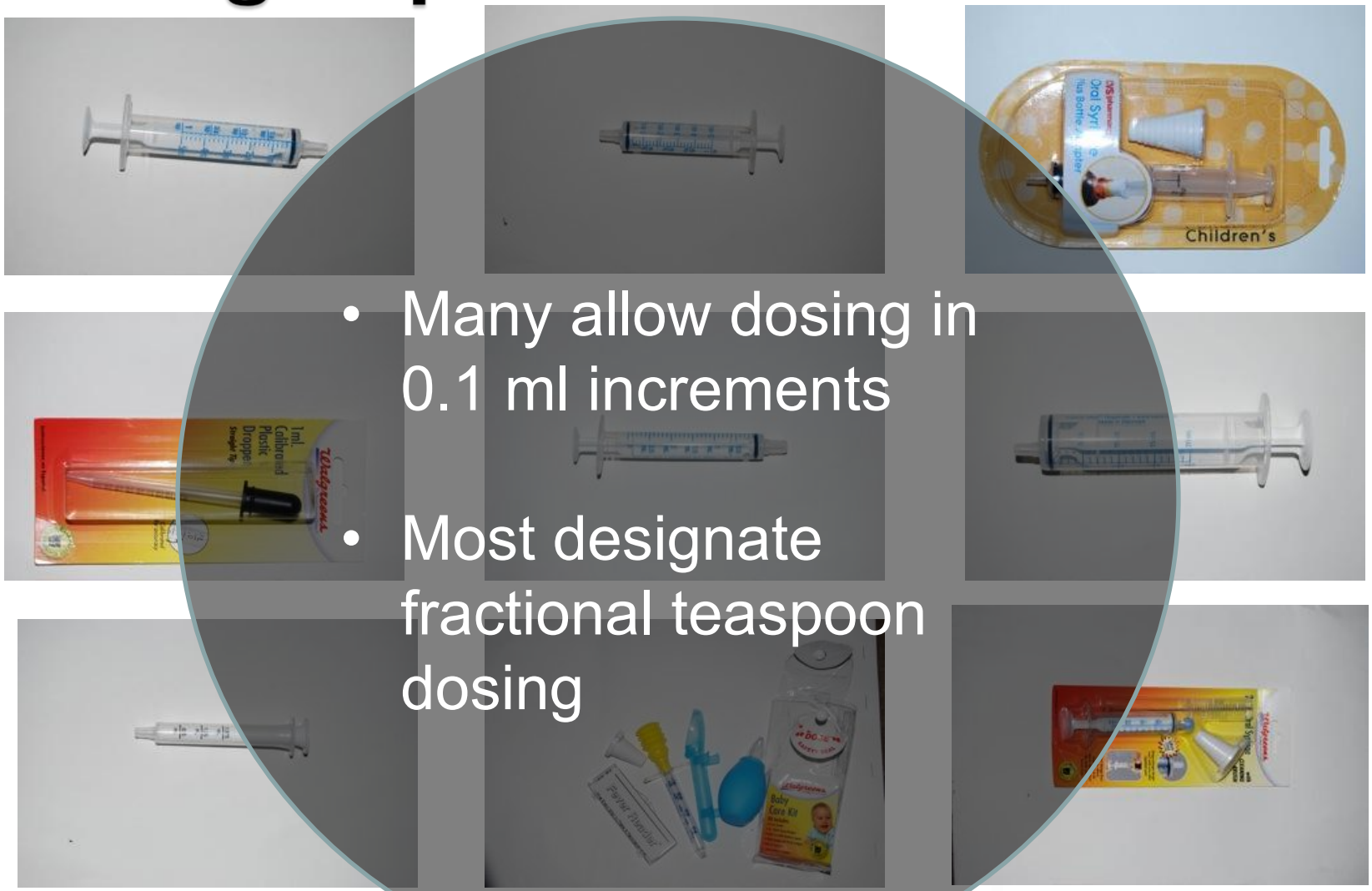
- Drug Literature review references:
  - Weight-based dosing guidelines
  - Minimum and maximum dosing
  - Drug toxicity and side effects

  - The Harriet Lane Handbook, 18th Edition
  - Lexi-Comp's Pediatric Dosage Handbook, 14th Edition
  - Basic and Clinical Pharmacology, 7th Edition
  - Thomson Reuters Healthcare database

Drug Information Model



Dosing Implements

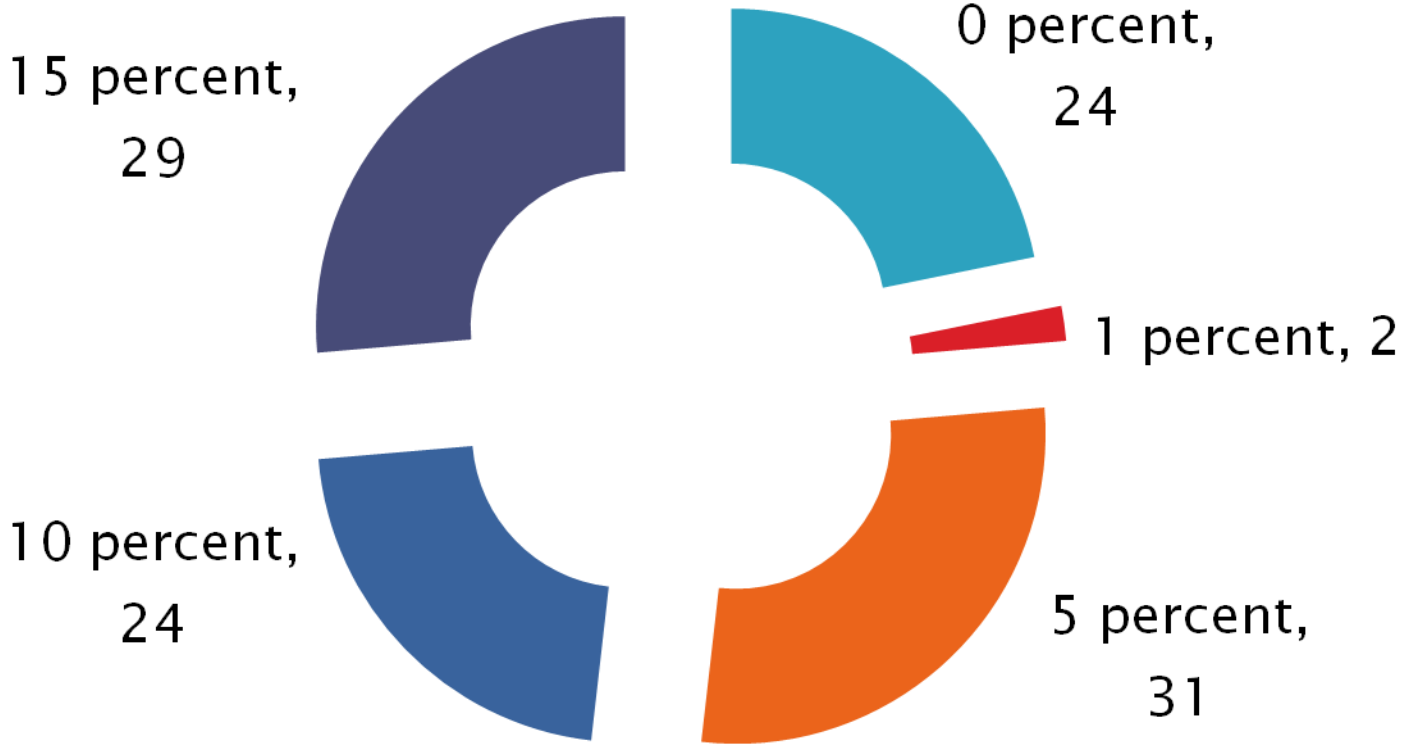


- Many allow dosing in 0.1 ml increments
- Most designate fractional teaspoon dosing

Literature Review/ Focus Group Results - Rounding Categories

1) Avoiding Unintentional Consequences
    - Dose-dependent side effects (ex. clindamycin)
2) Controlling Intended Effects
    - Impact of dose-dependent effects (ex. Lasix)
3) Toxicity
    - Narrow therapeutic index (ex. digoxin)
4) No pediatric dosing
    - Safety and Efficacy unknown (ex. Lyrica)

Rounding Percentages



Web Service for Distributed Use of Rounding Knowledge

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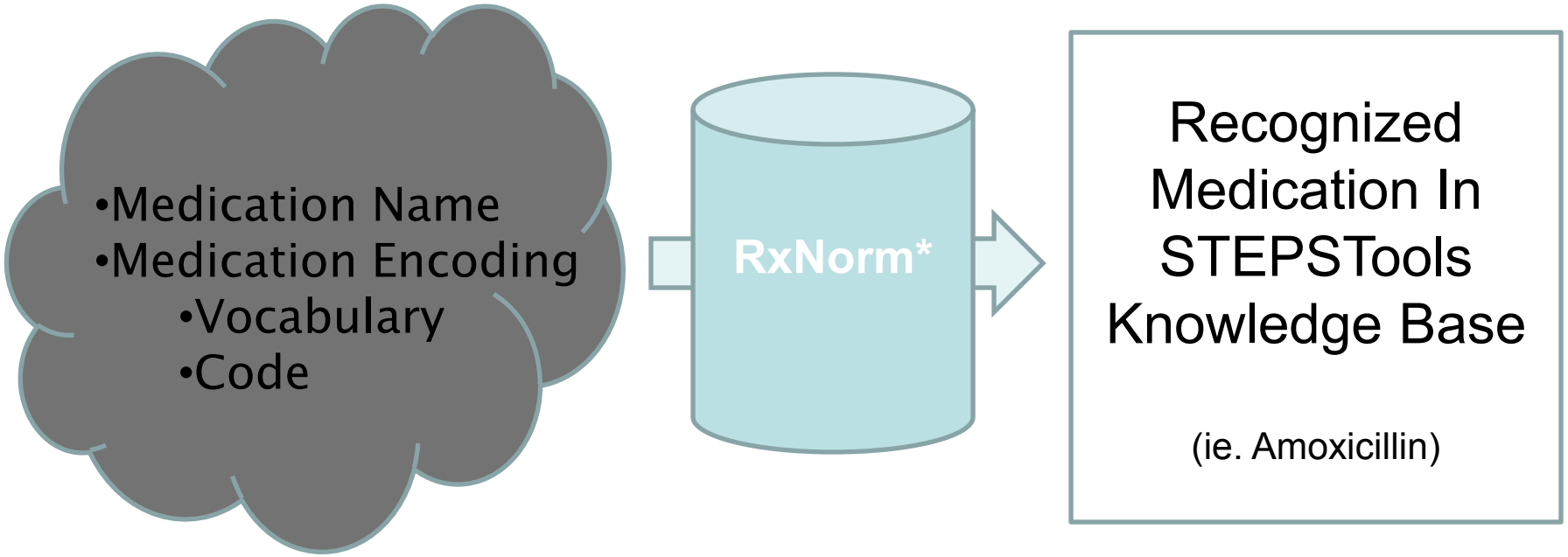
Values Expected To Come From E-Prescribing System To Web Service

E-Prescribing System Server

- Patient's weight in Kg
- Patient's age in months
- Medication Name
- Medication Encoding
- Mg/Kg Dosing Formula

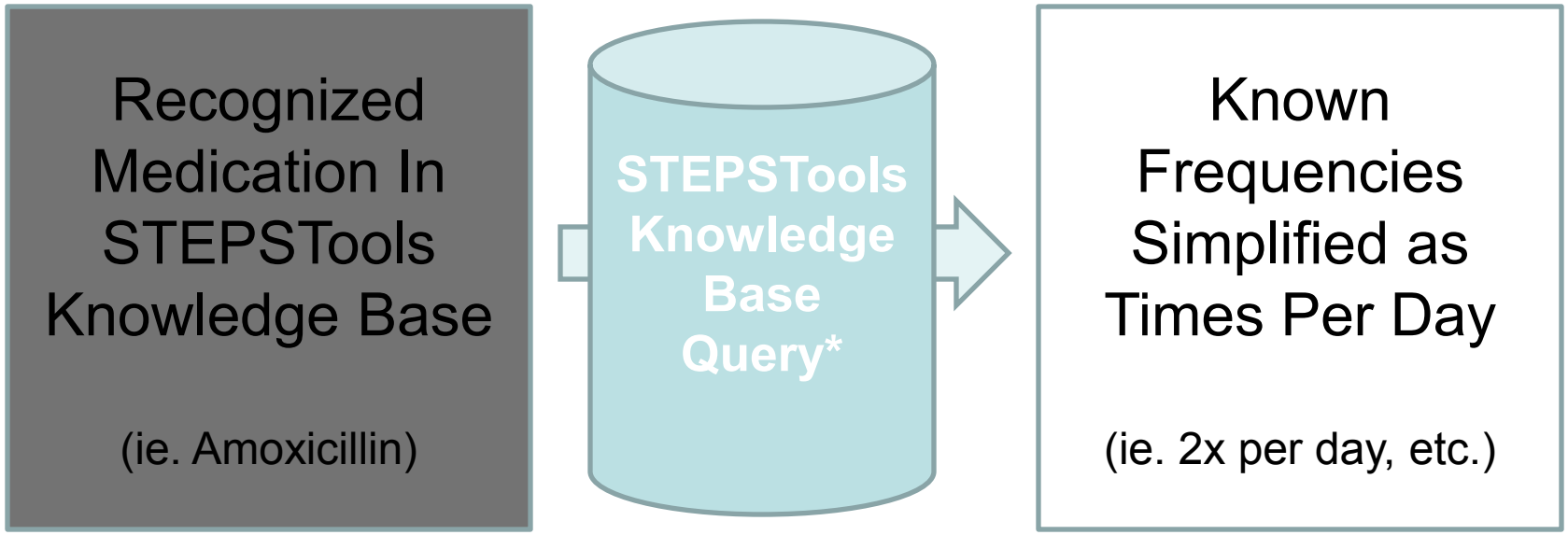
STEPSTools Server

Medication Mapping



* Attempt to map based on medication encoding first. If mapping fails, attempt to parse medication name (brand or generic) for recognizable match to medication in STEPSTools knowledge base.

Determine Common Frequencies



*What are the known commonly-used frequencies for this medication?

Calculate an exact dose

For each known frequency…

Patient Weight In Kilograms
from received values

(ie. 30 kg)

X

Mg/Kg Dosing Formula
from received values

(ie. 40 mg/kg/day)

/

Known Frequency
from knowledge base

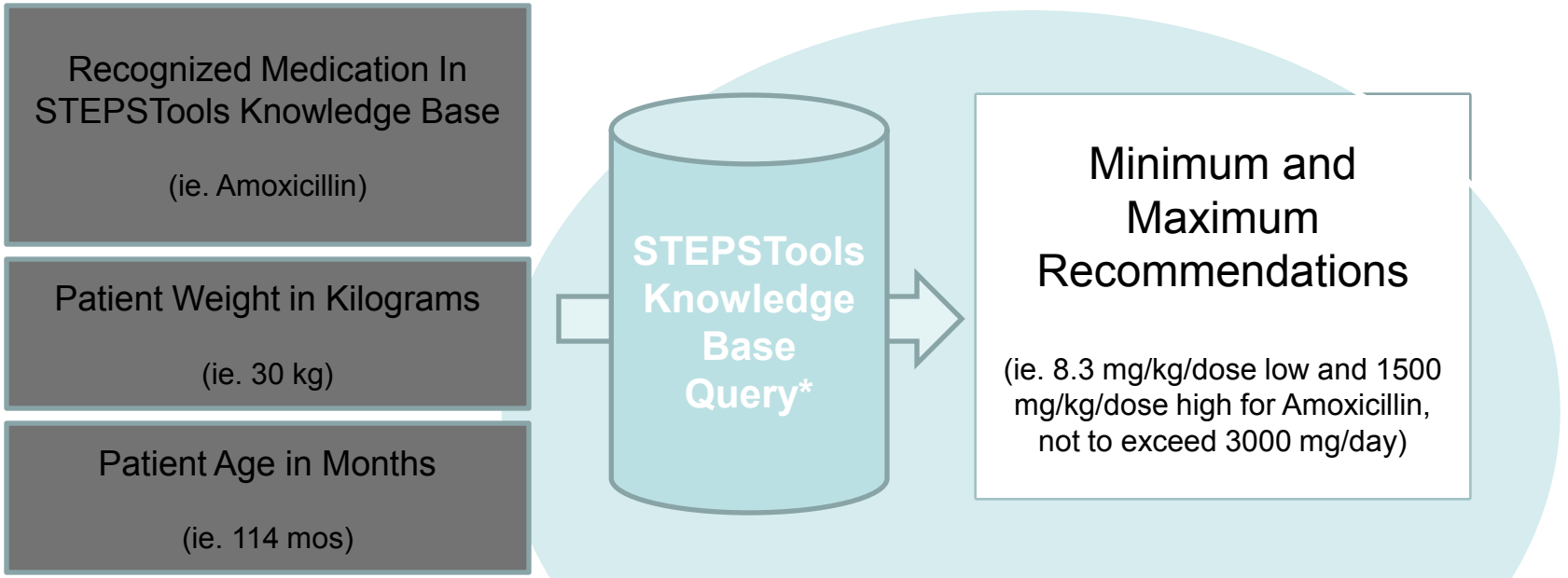
(ie. 2x per day)

=

Exact Calculated Dose Which Needs Rounding

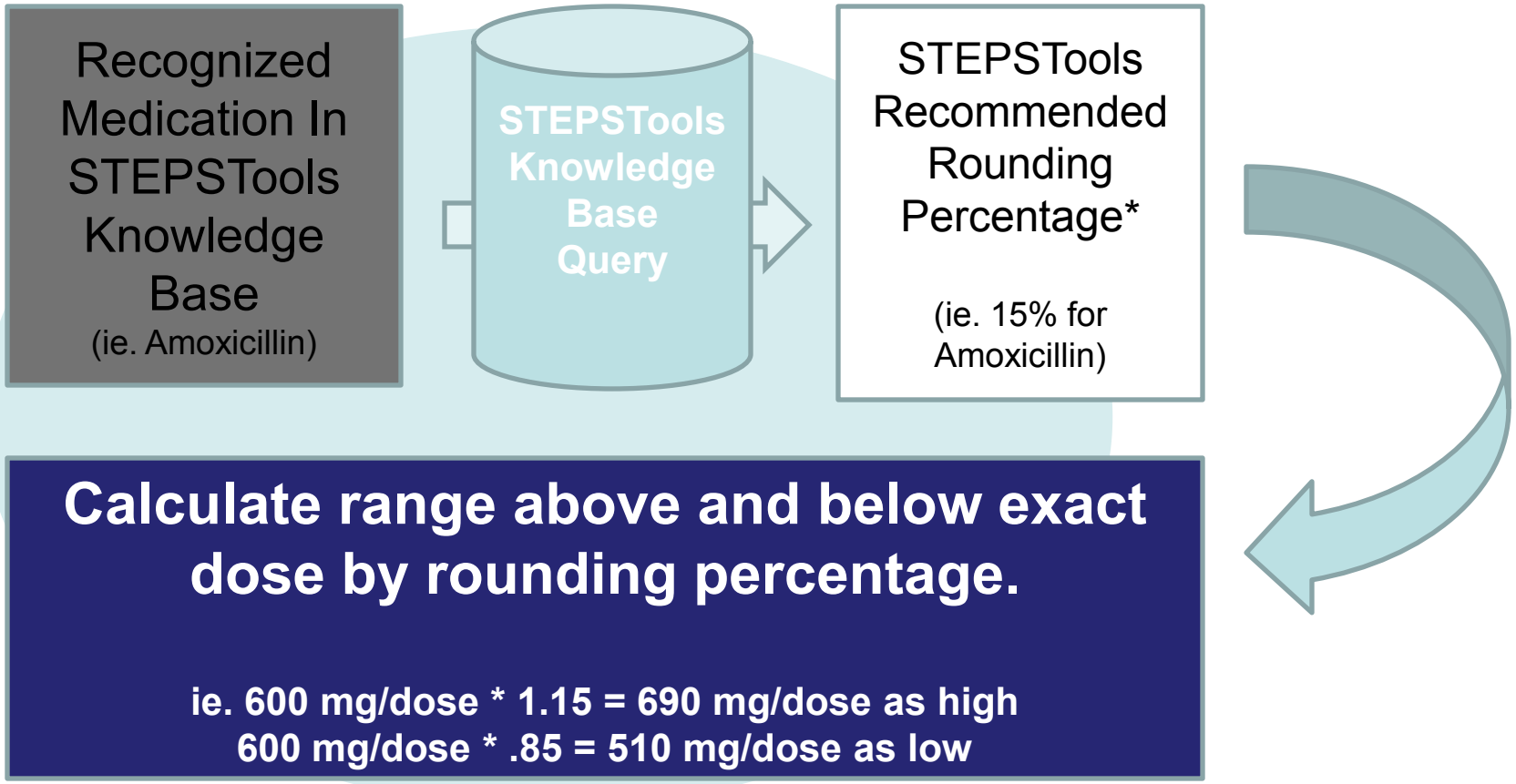
(ie. 600 mg/dose)

Determine Absolute Range



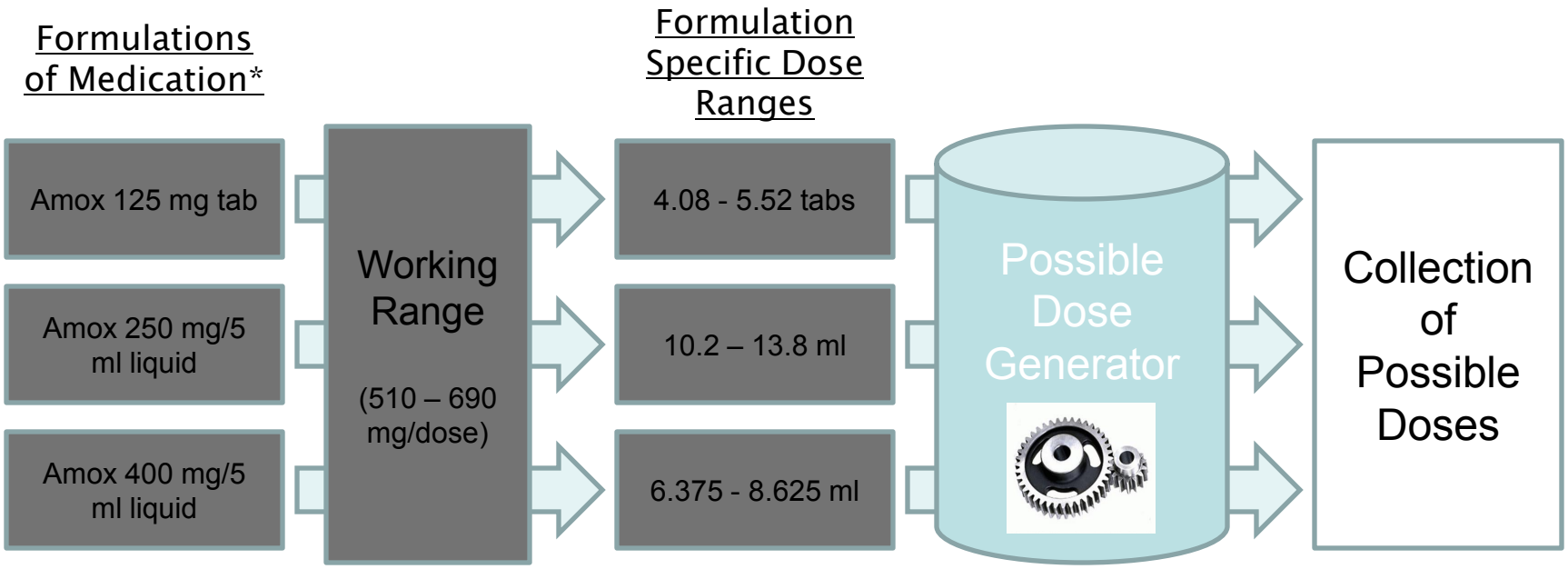
* Find the concatenation of age-based and weight-based absolute minimum and maximum recommendations for this medication as well as absolute maximum per day where applicable.

Determine Rounding Range



* Recommended percentages based on results from panel discussion of American Academy of Pediatrics and American Medical Informatics Association experts

Generate a List of Possible Doses Within the Working Range



*List of formulations for the medication are retrieved from a table in the STEPSTools knowledge base which was derived from data in RxNorm.

Possible Dose Generator Explanation

For each dose range…

Possible Dose Generator

Formulation Specific Dose Range

6.375 - 8.625 ml

Collection of Possible Doses

STEPSTools uses real-life increments appropriate to the form and dose range.

Score Possible Doses

Collection of Possible Doses

Scoring*

Collection of Possible Doses Sorted By Score

*Each dose scored based on a set of business rules.

Examples of Business Rules for Scoring Possible Doses

- If the age of the patient is less than 7 years, boost the score on doses in liquid or suppository form.
- If the form is liquid, boost the score of doses that are whole milliliter amounts.
- If the form is liquid, boost the score of doses that are greater than 1 milliliter but less than 10 milliliters.

Response Returned To E-Prescribing Server From Web Service

E-Prescribing System Server

- Frequencies, Calculated Doses
  - Working Range
  - Possible Ranges
  - Possible Doses Scored

STEPSTools Server

Next Steps

- Implementation in two vendor systems
- Evaluation of log files to assess
  - Frequency of use
  - Differences between high scoring doses and final orders
- Site visits to assess
  - Overall prescriber and prescriber agent perception of impact on e-prescribing
  - Pharmacy callbacks and perception of impact

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Thank You!

Questions & Answers

Our Panel:

George Hripcsak, M.D., M.S., professor and chair of Columbia University's department of biomedical informatics

Tejal Gandhi, M.D., M.P.H., board certified internist and associate professor of medicine at Harvard Medical School

Kevin B. Johnson, M.D., M.S., professor and vice chair of biomedical informatics; joint appointment in the department of pediatrics at Vanderbilt University Medical Center

Coming Soon!

Our Next Event

A webinar examining health information technology and underserved and vulnerable populations

Stay tuned for exact date and time

and information on how to register

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