

The In's and Out's of a Clinical Rules Engine

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Background – The Hospital

- Large tertiary care referral / teaching hospital
- 881 licensed beds
- 590 ADC
- 670 physicians
- >2,000 nurses



Background - Pharmacy

- 137 total fte's
- 65 pharmacists
- 89 Pyxis locations supporting a totally cartless distribution system
- Central pharmacy is automated using Omnicell PharmacyCentral Carousel System
- Unit based clinical approach
- 16 dedicated clinical specialists



Why a Rules Engine?

- We average over 14,500 active orders daily
- Daily an average of 6,300 new orders are generated
- Over 700 physicians are involved and more than 2,000 nurses
- Our formulary encompasses over 3,500 different products
- How else to keep patient medication issues from slipping between the cracks?

What is a “rules” engine

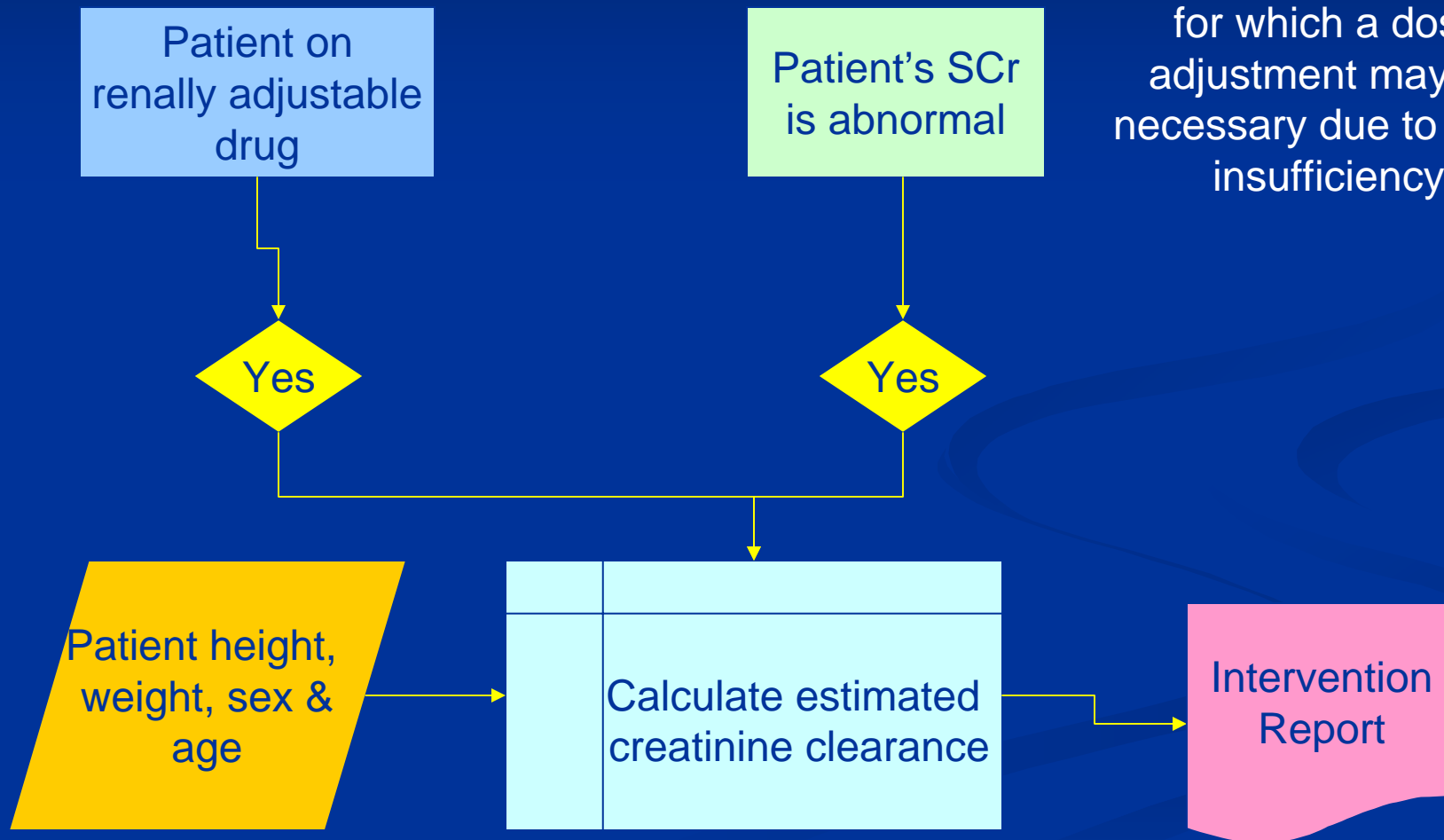
- Simply put, a “rules” engine is a product or process that uses (evaluates) available data against an algorithm (a set of criteria) to identify those sets of data that either meet the specified criteria or does not meet the specified criteria

Why a Rules Engine

- A rules engine does not get tired
- It never gets bored
- It never misses anything
- It documents EVERYTHING it does
- It offers no opinions
- It is consistent
- It does not forget, and always follows up
- It frees up pharmacist time to focus on the true task of a professional, evaluation and decision making

How does it work?

Patients on medications for which a dose adjustment may be necessary due to renal insufficiency

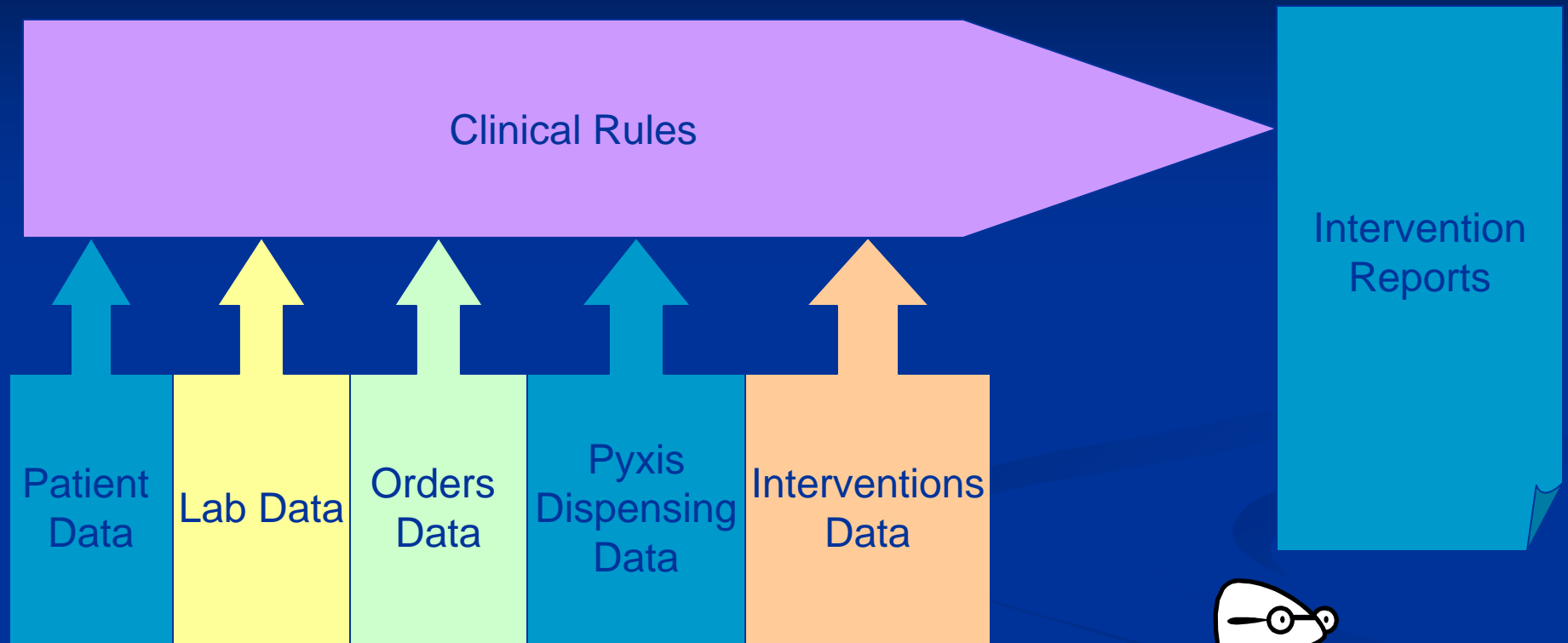


PhRED



- PhRED (Pharmacy Rules Engine Database) was developed using Microsoft Access 2003
- The current version of PhRED is 3.0
 - Version 1.0 was developed at Methodist Medical Center in Dallas during the 1990's using data extracted from our Cerner PharmNet system
 - Version 2.0 was developed at Saint Francis Hospital in Tulsa using data extracted from the PerSe Clinical System

PhRED Data Sources



What Does PhRED Do?

- Renal Alerts
- IV to PO Alerts
- Trigger Drug Alerts
 - Diphenhydramine
 - Keyexelate
 - Naloxone
- Elevated Potassium Alert
- Warfarin Monitor
- Drug Interaction – Metoclopramide / Antiparkinson Agents
- Drug Interaction – Meperidine or Imipenem/Cilastatin and anticonvulsants
- Patient Transfers – Med Rec
- Toxicity Alert (Acetaminophen > 4,000 mg)
- Cardiac Monitor – ASA
- Intrathecal Alert
- HIT Alert
- Methotrexate Alert
- Colchicine Alert
- LMWH vs Heparin Alert
- Drug Interaction – Cations
- Geriatric Alert
- ACEI / ARB in MI
- ACEI / ARB in HF
- Duration of Therapy
- Pyxis Overrides

PhRED Activity


- These rules collectively fire an average of 22,000 times a month
- PhRED automatically tallies
 - Who runs what reports
 - How many times a given rule triggers
 - Patient admits / discharges / transfers, by unit
 - New orders / existing orders, by unit

Staff Response

- In all three hospitals the staff response to the clinical rules engine followed the same path
 - Initial skepticism
 - Some reports had a “wow” factor
 - Some reports “needed work”
 - Finally, a steady flow of “can it do this”
- Staff response has been great with a feeling that it saves time for the pharmacist and benefits patient care

PhRED

Main Form



PhRED

Pharmacy Rules Engine Database

Step One LOGIN

Step Two Update Active Orders

Step Three Run Routine Reports

View Transaction Log

Pyxis Based Reports

Run Reports - Special


Database Updated?

Pyxis Data Current?

Manually Update Pyxis


Table Maintenance

Other Reports and Graphs



This updates this application's "history" of active orders from the master Oracle database. This takes about 15 minutes to run to completion.

Main Form



PhRED

Pharmacy Rules Engine Database

Run Routine Reports


Run Pyxis Based Reports

Run Special Reports

Database Updated??

Pyxis Data Current?

Other Reports



PhRED Reports

Main Form
Huntsville Hospital Pharmacy Services
Clinical Rules Engine

Housewide | Pyxis Related | Non-Pyxis Related

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Renal Alerts	Colchicine Alert	Daptomycin - CPK Alert
K Elevate Alert	Geriatric Alerts	Aspirin- Plavix Alert
Warfarin Monitor	DI-Cation Alert	Epoetin Alert
LMWH vs Heparin	HIT Report	Meperidine - Imipenem DI
Intrathecal Alert	Hypertonic Saline	Metoclopramide DI
Methotrexate Alert	Medication Reconciliation - Transfers	Ranexa DI
Ceftriaxone < 3 mos		LMWH vs LMWH
Ceftriaxone - Ca DI		Transfer Med Rec Report

Report Examples - Renal

Huntsville Hospital Pharmacy Services
Renal Alerts Report

2W-M-258P **MOND T** **SEWARD** GENDER: M RACE: B Age: 65.3
 -- -- DOB: 01/22/1943

Physician: M **Renally Adjustable Drug:** METOCLOPRAMIDE LIQUID 5MG/5ML,
 (VERIFIED) (REGLAN,OCTAMIDE) METOCLOPRAMIDE LIQUID 5MG/5ML, VIA G-TUBE, Q6H, (04/10/08
 24:00--), (E228)

This order has been active for (days): 4.0 **Classification:** Automatic

Comments <50=50% of normal dose (i.e. 5mg q6-8h), <10=25% of normal dose.

Date/Time	Lab	Value	CCL One	CCL Two	CCL Three	IBW	Weight	Variation % From IBW
04/15/2008 06:28:58 AM	CREATININE	6.8	8.3	8.7	13.9	73.0	54.54	-25.3
04/14/2008 06:10:03 AM	CREATININE	5.5	10.3	11.5	17.2	73.0	54.54	-25.3
04/13/2008 06:02:41 AM	CREATININE	3.9	14.5	17.4	24.3	73.0	54.54	-25.3
04/12/2008 02:50:35 AM	CREATININE	4.9	11.6	13.3	19.3	73.0	54.54	-25.3

Pt Weight is more than 10% less than IBW **Height:** 177.8 cm 70.0 in
is not Applicable
is not Applicable
Patient has height and weight information
 CCL One - Unadjusted Cockcroft-Gault formula, CCL Two - [(145-age)/Scr]-3 (x.85 if female), CCL Three - Males:[120-(age-40)]/Scr, Females:[100-(age-40)]/Scr

Pharmacy Notes on this patient...

04/14/2008	DVT RISK ASSESSMENT REVIEWED; LOW H&H
04/12/2008	ADMISSION MED REC PERFORMED
04/12/2008	PHARMACY NOTES--PTS HOME MD IS RENAGL PER G-TUBE-JB
04/12/2008	PHARMACY NOTES--LEFT NOTE FOR MD ABOUT RENAGEL CRUSHING-JB

Patient Info

Order Info

Lab Info / Calculations

Pharmacist Notes Info

Report Examples - Toxicity

Huntsville Hospital Pharmacy Services - Drug Toxicity Monitor

This report uses Pyxis archive data to reveal patients who had more than 3 grams of acetaminophen retrieved from Pyxis. The supposition is that the patients generally receive what is removed from Pyxis. Please review the MAR and consult with the nurse or physician to reduce the daily load of acetaminophen.

5MST -1555P

GENDER: M Age: 34.7 DOB: 08/11/1973 RACE: W

Date Withdrawn	Acetaminophen Containing Medication	Acetaminophen / dose (mg)	Units Withdrawn	24 Hour Dose Withdrawn
04/14/2008 12:43:52 AM	NORCO 10/325 (CIV) 0 TABLET 0	325	2	650
04/14/2008 05:32:31 AM	NORCO 10/325 (CIV) 0 TABLET 0	325	2	650
04/14/2008 10:44:51 AM	NORCO 10/325 (CIV) 0 TABLET 0	325	1	325
04/14/2008 02:03:39 PM	NORCO 10/325 (CIV) 0 TABLET 0	325	2	650
04/14/2008 05:26:19 PM	NORCO 10/325 (CIV) 0 TABLET 0	325	2	650
04/14/2008 10:10:53 PM	NORCO 10/325 (CIV) 0 TABLET 0	325	2	650

Total Acetaminophen Taken (mg): 3,575

Liver Function Tests - If Any

Lab Date/Time	Lab Description	"Normal" Range	Result	Comment
04/13/2008 04:04:24 AM	ALT	(<42)	12.0	Normal
04/13/2008 04:04:24 AM	ALBUMIN	(3.2-4.8)	2.9	Low
04/13/2008 04:04:24 AM	AST	(<39)	9.0	Normal
04/14/2008 03:08:21 AM	ALT	(<42)	16.0	Normal
04/14/2008 03:08:21 AM	ALBUMIN	(3.2-4.8)	3.3	Normal
04/14/2008 03:08:21 AM	AST	(<39)	7.0	Normal

Patient Info

Pyxis Dispensing History

Liver function related Labs – If available

Heparin / LMWH Report

6E-M

6E-IVCV14C

ALAN THOMAS DEWAYNE

GENDER: M RACE: W DOB: 12/16/1958

LMWH Order

ENOXAPARIN INJ 04/20/2008 05:36:00 PM STATUS: Active
(LOVENOX) ENOXAPARIN INJ 40MG (FORMULARY SUB FOR DOSES 35-44MG),
(**ANTICOAGULANT**) SC DAILY AT, 18:00, STARTING TOMORROW, (04/21/08 18:00-.), (02
OF 02), (1113)

Heparin Order

04/18/2008 07:30:00 PM STATUS: Active
(COMPLETE) IV ORDER....START NS, 500ML, W/ HEPARIN 3000 UNITS
(**ANTICOAGULANT**), RATE-FOR IABP FLUSH, CONT TIL DC"D, <04/17/08-., (1100)

- Detects simultaneous orders for heparin and low molecular weight heparin
- Issues highlighted are **USUALLY** ones of timing
- We verify that one order stops before the other begins.

High Risk Meds

Warfarin Monitor

Warfarin is a high risk / high alert medication. This report lists all patients who are on, or have recently been on, warfarin, along with their INR lab values.

Patient ID / Name

10

2E-M

2E-M- 290P

WARFARIN NA TAB (DC) (COUMADIN) WARFARIN NA TAB 4MG, #1, PO, QHS, (04/21/08 4MG, 21:00-...), (1349)

Date	Lab	Result	Range	Flag
04/21/2008 09:28:36 AM	INR	1.6		Normal
04/22/2008 02:10:47 AM	INR	1.7		Normal
04/24/2008 06:57:31 AM	INR	1.6		Normal

01-----

Warfarin Doses from Pyxis

Pyxis Date	Drugs	Quantity Removed
04/22/2008 08:17:07 PM	COUMADIN 4 MG TABLET	1

Pharmacy Notes ...

04/21/2008 DVT RISK ASSESSMENT REVIEWED; WARFARIN
04/21/2008 ADMISSION MED REC PERFORMED
04/23/2008 04:24:03 P form sub lovenoxD-

The Order

The Labs

Actual doses

Documentation history

Pyxis Override Review

Date	Time	Medication	Amt
3NE-ORTHO			
[REDACTED]			
04/24/2008	- 02:59:35 PM	ONDANSETRON 4 MG VIAL 2 ML (13410)	1
3NWM-340A			
[REDACTED]			
04/24/2008	- 12:30:01 PM	PROMETHAZINE INJ. 25 MG AMPULE 1 ML (31472)	1
3NWM-341B			
[REDACTED]			

- Every pharmacist gets a report customized for the areas they cover
- It details all of the medications removed on override for their particular area
- They review these doses for appropriateness and bring exceptions to the nurse manager's attention

Transfer Medication Reconciliation

Huntsville Hospital - Department of Pharmacy Services Medication Reconciliation Tool - Patient Transfer Tracker

This report includes all newly transferred patients (from one level of care to another) and any patients previously transferred whose transfer medication reconciliation has not been documented.

Tracks patient movement from one unit to another for the days 04/24/2008 to today - 04/25/20

5W-M

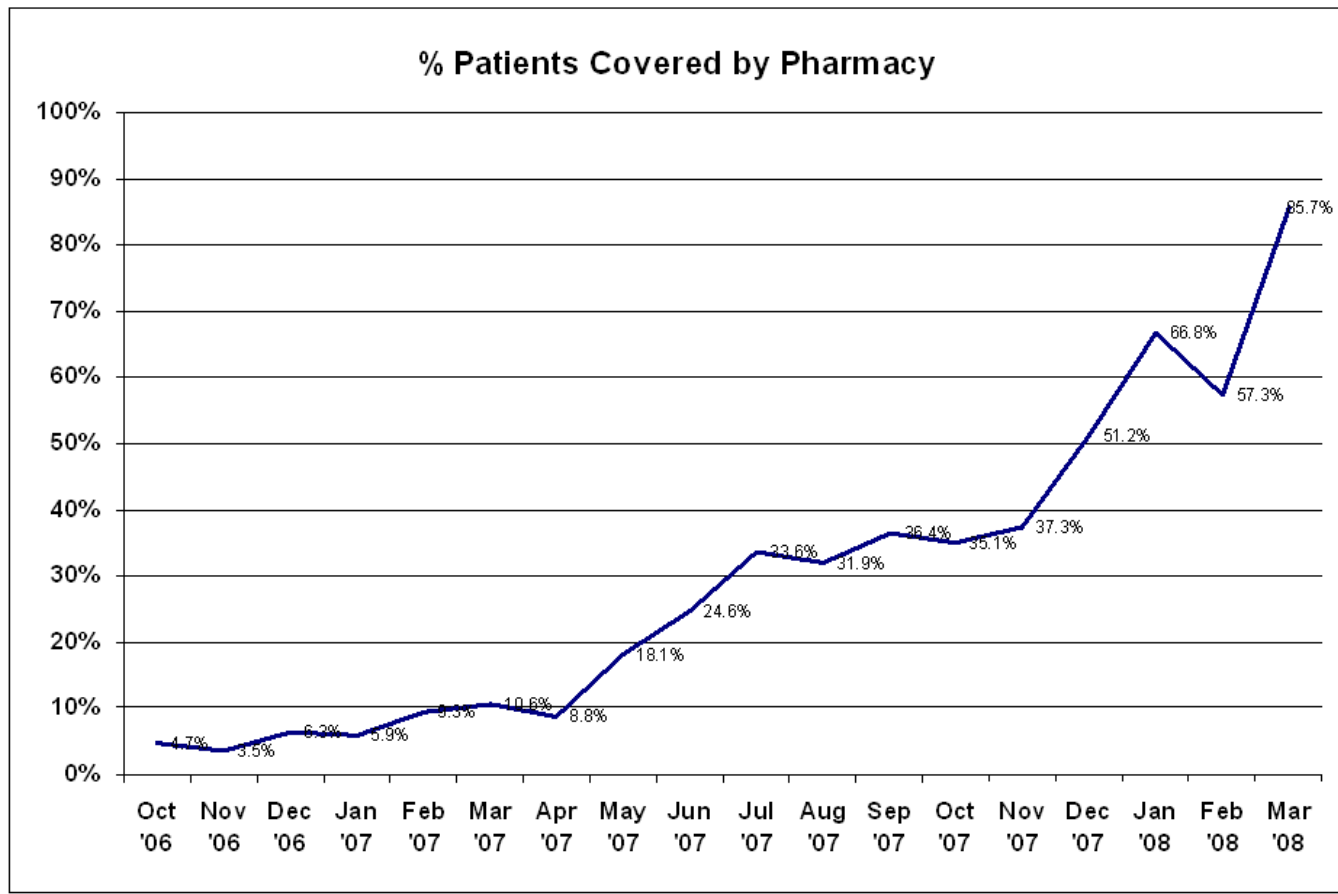
04/22/2008	7N-M	8NEM
04/25/2008	8NEM	5W-M
04/22/2008 TRANSFER MED REC PERFORMED ON MOVE TO 8NE		

04/16/2008	3E-M	6E-M
04/23/2008	6E-M	5W-M
04/16/2008 TRANSFER MED REC PERFORMED ON MOVE TO 6E		

- Patient transfers between Levels of Care (LOC) can be difficult to track and/or hard to remember
- PhRED gives us the capability to track and remember
- This report links to our on-line documentation of Med Rec completion to remind the pharmacist
 - Of the transfer
 - Of a missing reconciliation documentation

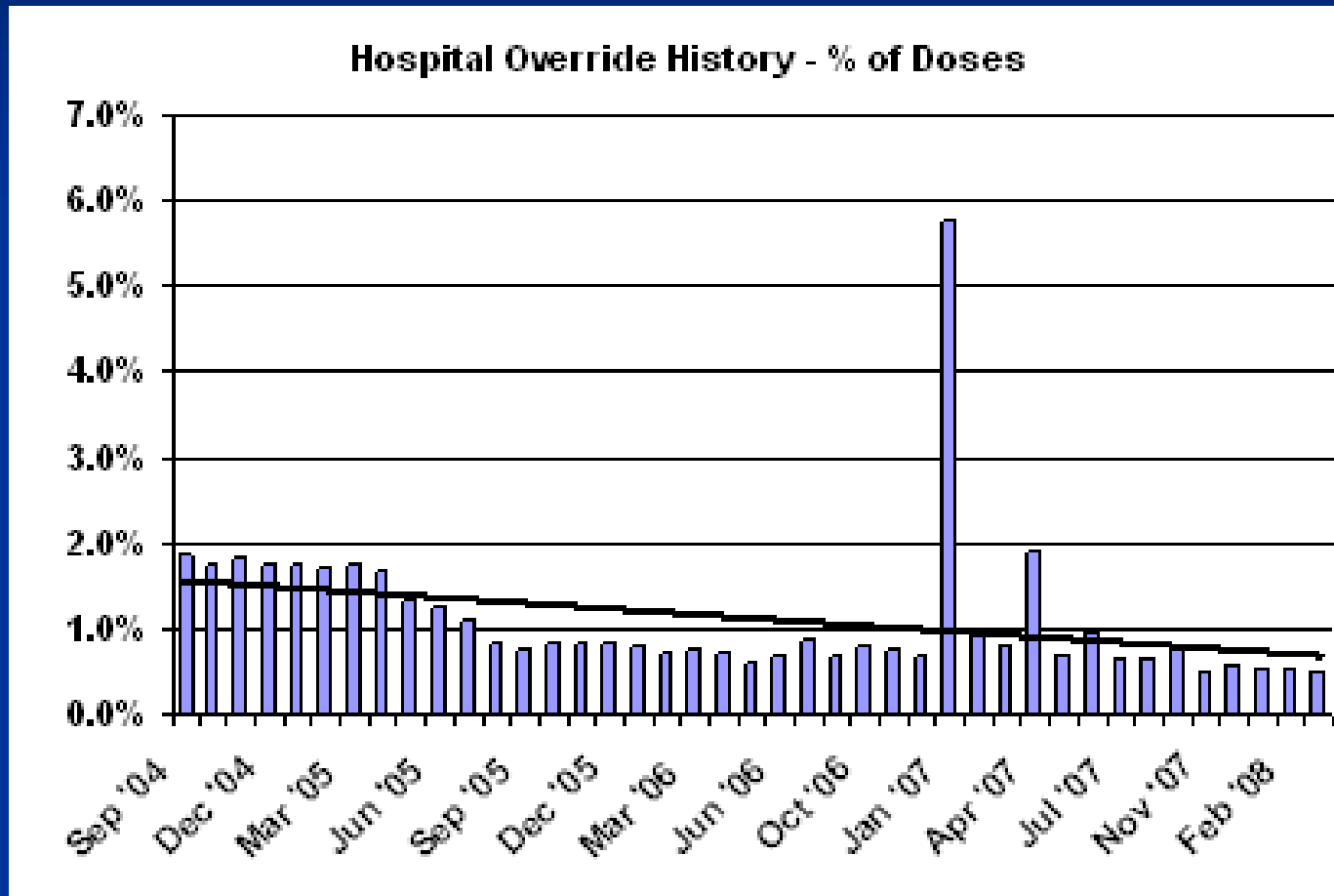
Transfer Med Rec Performance

Medication Reconciliation Performance Measures - Transfers



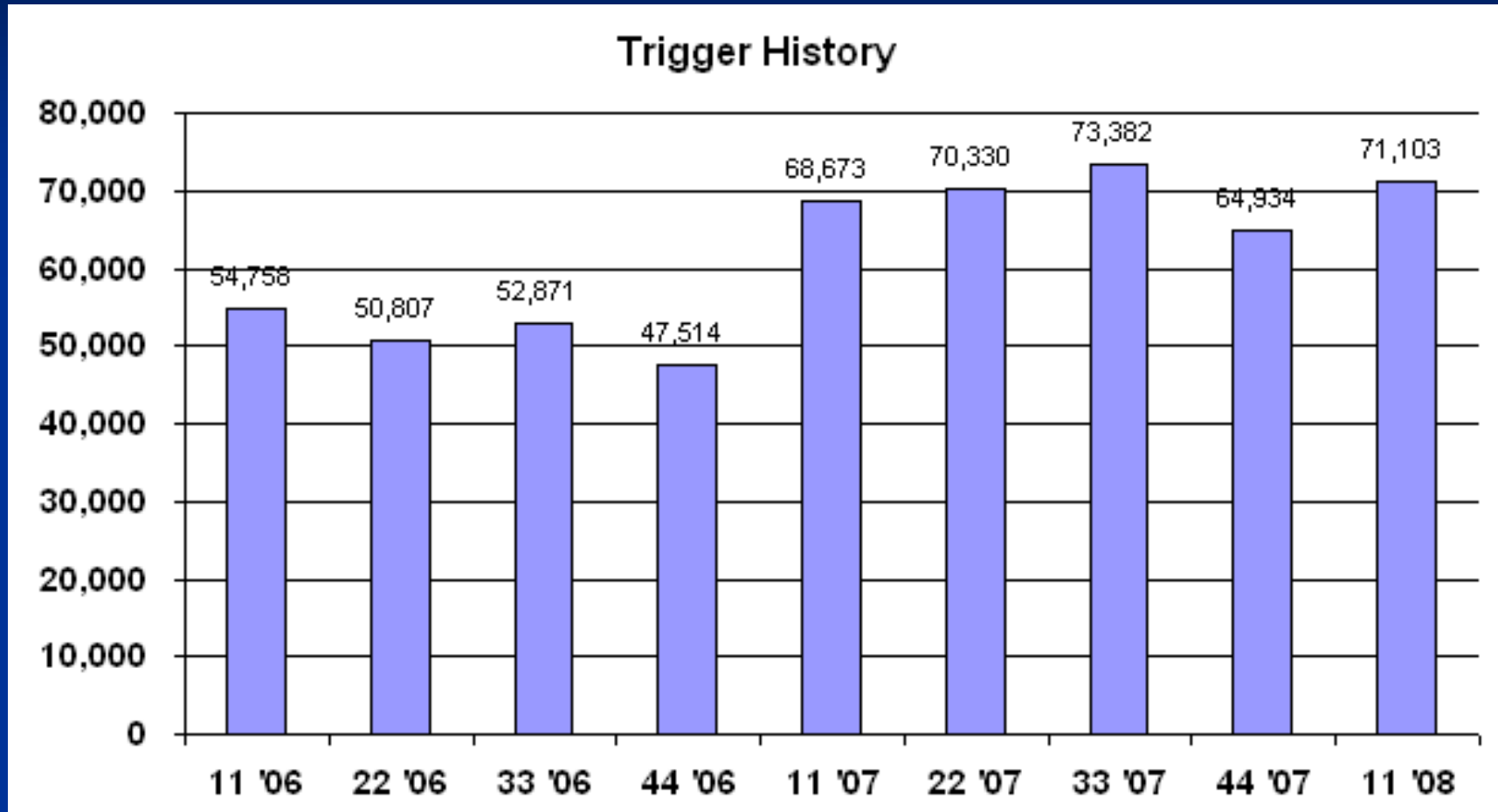
What a difference a useful report can make!

Pyxis Override Utilization



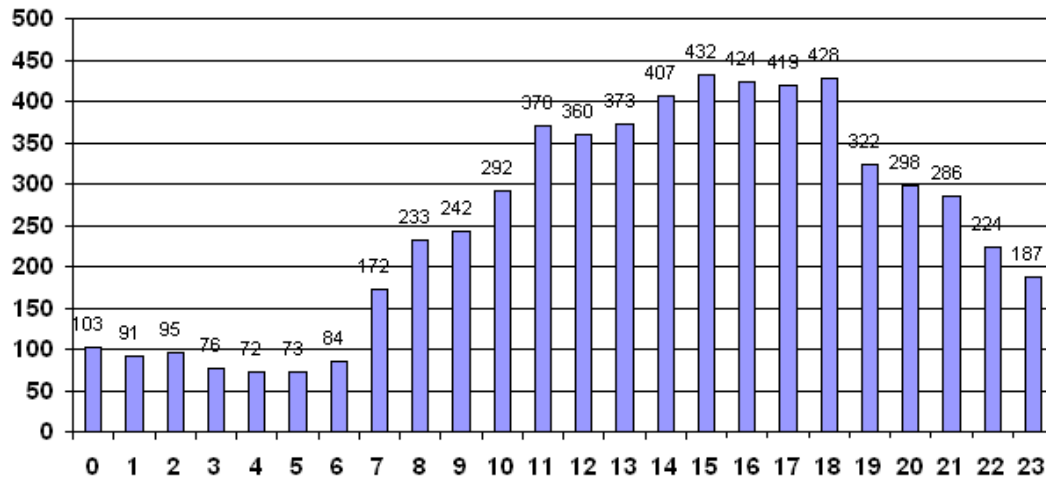
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Overall PhRED Activity

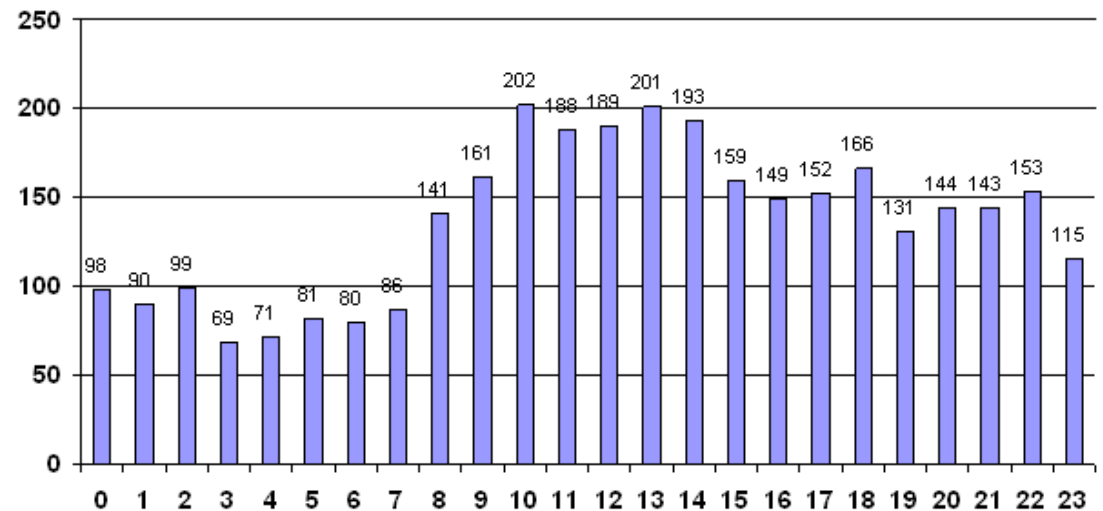


Other Useful Information

Order Review by Hour - Weekdays



Orders Reviewed by Hour - Weekends

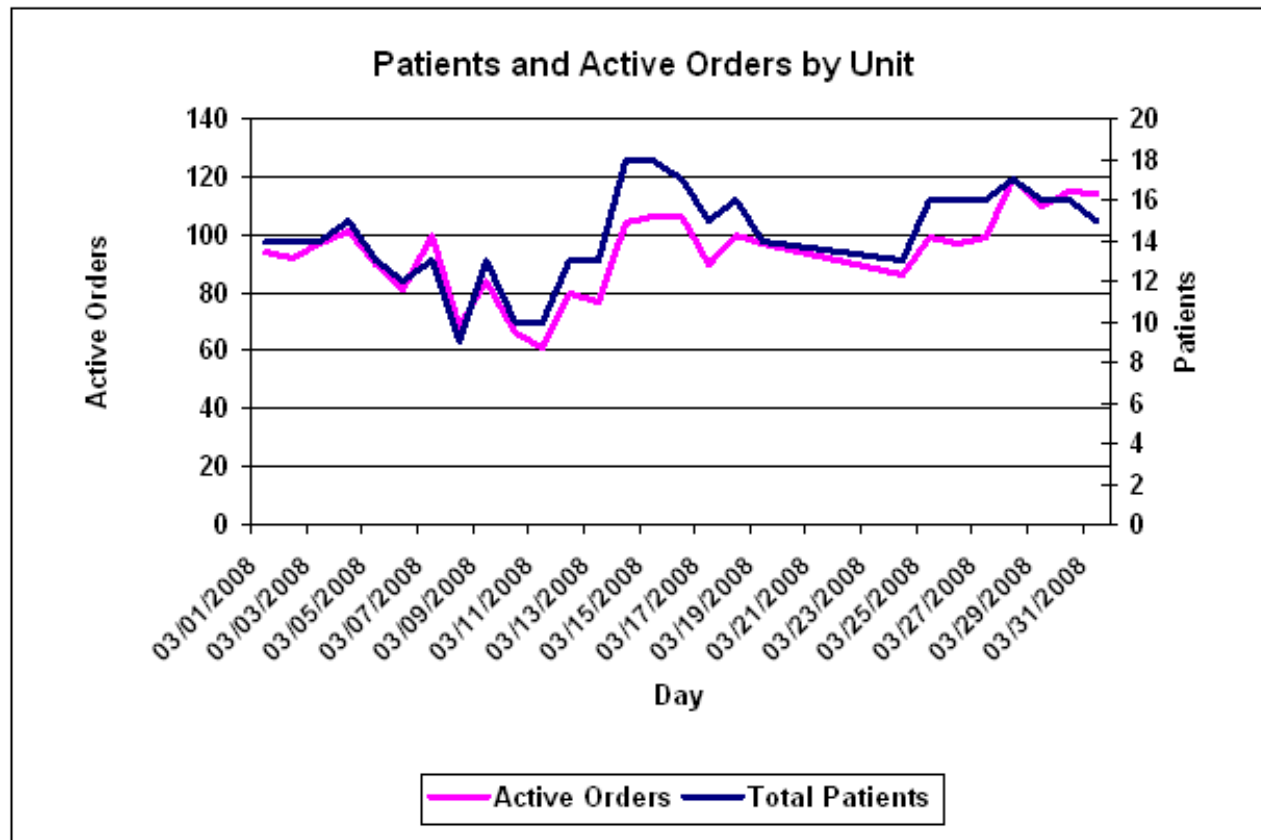


Averages per hour for
the last 90 days

Other Useful Information

Huntsville Hospital
Department of Pharmacy Services
Workload Trends - Patients and Active Orders by Unit

3EIE



Issues with PhRED

- Totally homegrown – support 24/7/365 is an issue (I like to sleep!)
- Reactive format
- Currently set up to run once daily (24 hour gap)
- Paper only
- Follow-up and documentation is difficult
- Limited integration with other databases
- Subject to 2 gigabyte MS Access 2003 limitations
- Difficult to teach to others... MS Access has difficult learning curve
- Rules must be carefully written – a poorly written rule can lead to errors as easily as preventing errors

The Future

Overall Clinical Rules Structure

GE Centricity Blaze Rules

- GE rules used for concurrent checking of desired circumstances
 - Presence of INR for new warfarin order
 - Presence in potassium level WNL for new potassium order
 - Automatic ordering of labs with orders for certain drugs

PhRED

- Senti7 used for those items needing a more “real time” approach
 - Renal alerts
 - IV to PO
 - Many of the current PhRED reports
- PhRED will be reserved for those clinical rules too complex or requiring data not available to the other two rules engines

Senti7

The Future

- GE Blaze rules will be formulated by pharmacists but written and maintained by IT
- Senti7 will enable the training of more people to support the development of a more comprehensive rules environment
 - All rules will still be subject to the Director's approval before implementation
- Senti7 will take some support and development load off of PhRED's author

Summary

- Clinical rules are indispensable
- Wisely used they can greatly stretch the abilities of the average pharmacist to make above average “catches” and interventions
- Vastly improves medication issue detection rates
- Helps to document the work done, and the work yet to be done
- No single approach will probably capture all medication process improvement opportunities
- The tools can be used to guide medication process improvement opportunities
- Think OUTSIDE the box!
- Never, ever, leave well enough alone!