Utilizing Automated Adverse Event Detection

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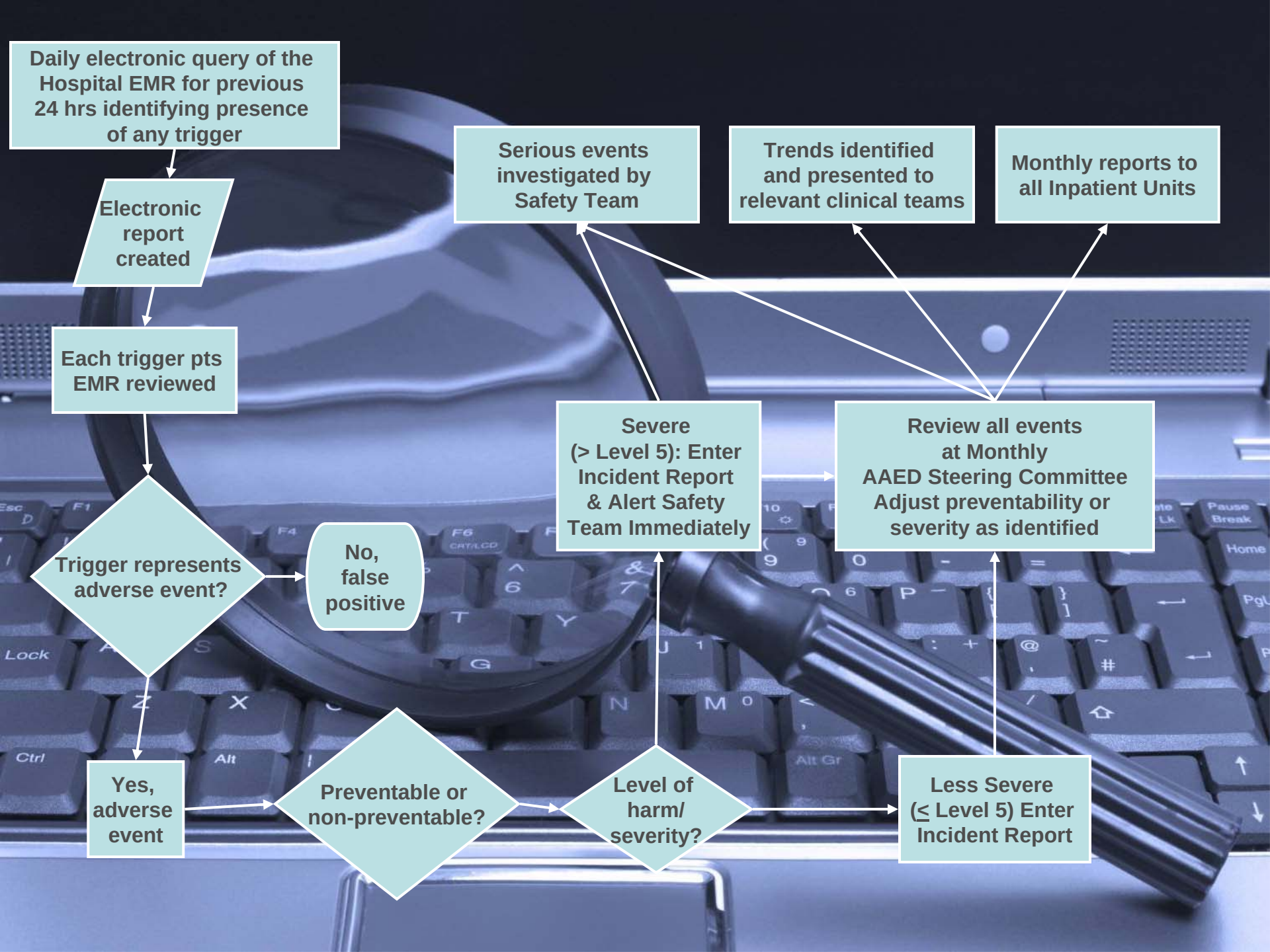
August 17th, 2010

What are the problems with Manual Trigger Methods?

- Small sample size
- Subject to errors in detection
- Resource intensive

Benefits of using an electronic trigger system?

- Focused chart review
  - Less Time
  - Less expense
- Better accuracy
  - Electronic detection
  - Repeatability and therefore reliability
- Higher capture rates
  - Better positive predictive value
- Improved detection of preventable errors
  - Better able to correct process problems
  - Quality assurance/quality control

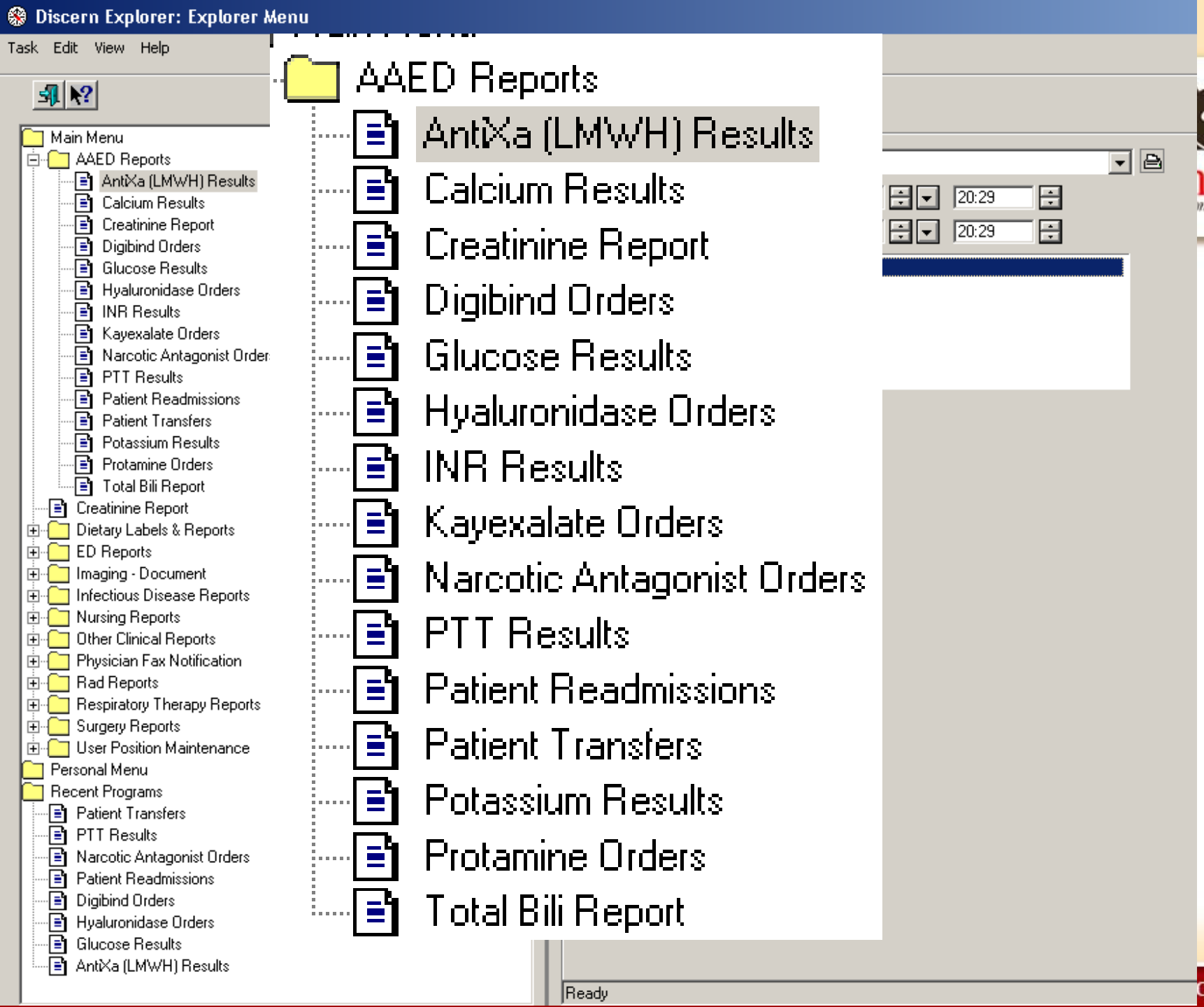

Daily electronic query of the Hospital EMR for previous 24 hrs identifying presence of any trigger
Electronic report created
Each trigger pts EMR reviewed
Trigger represents adverse event?
No, false positive
Yes, adverse event
Preventable or non-preventable?
Level of harm/ severity?
Severe (> Level 5): Enter Incident Report & Alert Safety Team Immediately
Less Severe (≤ Level 5) Enter Incident Report
Review all events at Monthly AAED Steering Committee Adjust preventability or severity as identified
Serious events investigated by Safety Team
Trends identified and presented to relevant clinical teams
Monthly reports to all Inpatient Units

Inclusion Criteria

- Electronically identifiable
- Frequency of trigger
- Favorable positive predictive value of detecting an adverse event
- Anticipated serious level of harm
- Expected adverse events are not being investigated by other teams at local institution

Trigger Utilization

Children's National Medical Center	Active/ Retired	Months in use	Adverse Event Risk
Medication Administration			
Digoxin immune fab	Active	34	Digoxin overdose/overuse
Flumazenil	Active	34	Benzodiazepine over-sedation
Hyaluronidase	Active	16	Limit impact of IV Infiltrate
Kayexalate	Retired	34	Potassium supplements or potassium sparing medication overdose/overuse
Naloxone	Active	34	Opiate over-sedation
Protamine	Active	34	Heparin overdose/overuse
Laboratory Value			
Anti Factor Xa > 1.5	Active	16	LMWH Overdose/overuse
(aPTT) > 100 seconds	Active	25	Heparin overdose/overuse
Bilirubin > 25 mg/dl	Active	12	Management of neonatal hyperbilirubinemia
Creatinine Doubling from Baseline	Active	8	Impact of nephrotoxic medications
Glucose < 50 mg/dL	Active	34	Hypoglycemia related to care
international normalized ratio (INR) > 4.0	Active	25	Warfarin overdose/overuse
Ionized calcium (iCal)> 1.5 mmol/L	Retired	10	Calcium supplement overdose/overuse
Potassium > 6.0 mmol/L	Retired	9	Potassium supplements or potassium sparing medication overdose/overuse
Admission, Discharge, Transfer			
Transfer to an intensive care unit (ICU)	Active	30	Missed diagnosis/ appropriate discharge criteria not met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Task Edit View Help
Main Menu
AAED Reports
AntiXa (LMWH) Results
Calcium Results
Creatinine Report
Digibind Orders
Glucose Results
Hyaluronidase Orders
INR Results
Kayexalate Orders
Narcotic Antagonist Order
PTT Results
Patient Readmissions
Patient Transfers
Potassium Results
Protamine Orders
Total Bili Report
Creatinine Report
Dietary Labels & Reports
ED Reports
Imaging - Document
Infectious Disease Reports
Nursing Reports
Other Clinical Reports
Physician Fax Notification
Rad Reports
Respiratory Therapy Reports
Surgery Reports
User Position Maintenance
Personal Menu
Recent Programs
Patient Transfers
PTT Results
Narcotic Antagonist Orders
Patient Readmissions
Digibind Orders
Hyaluronidase Orders
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Glucose Results
Hyaluronidase Orders
INR Results
Kayexalate Orders
Narcotic Antagonist Orders
PTT Results
Patient Readmissions
Patient Transfers
Potassium Results
Protamine Orders
Total Bili Report
20:29
20:29
Ready

Report Output - Creatinine Report

Task Edit View Help

Query Output - Creatinine Report

Task Edit View Help

100%

	NURSE_UNIT	FIN_NUMBER	MRN_NUMBER	LAB_TEST	ACC_NUM	RESULT_DT	RESULT_VAL	BASE_DT	BASE_VAL
1	3E	[redacted]		Creatinine result	[redacted]	01/27/2010 21:00	1.3mg/dL	01/25/2010 18:35	0.6mg/dL
2	3E			Creatinine result		01/28/2010 05:56	0.7mg/dL	01/17/2010 00:42	0.3mg/dL
3	3E			Creatinine result		01/27/2010 03:47	1.2mg/dL	01/21/2010 03:37	0.5mg/dL
4	3E			Creatinine result		01/27/2010 13:13	1.2mg/dL	01/21/2010 03:37	0.5mg/dL
5	3E			Creatinine result		01/28/2010 00:02	1.2mg/dL	01/21/2010 03:37	0.5mg/dL
6	3E			Creatinine result		01/28/2010 15:55	1.0mg/dL	01/22/2010 03:36	0.4mg/dL
7	3E			Creatinine result		01/27/2010 04:10	0.6mg/dL	12/16/2009 03:45	0.2mg/dL
8	3E			Creatinine result		01/28/2010 03:52	0.6mg/dL	12/16/2009 03:45	0.2mg/dL
9	3E			Creatinine result		01/26/2010 04:42	1.7mg/dL	01/06/2010 13:00	0.8mg/dL
10	3E			Creatinine result		01/27/2010 04:53	1.6mg/dL	01/07/2010 06:00	0.7mg/dL
11	3E			Creatinine result		01/28/2010 04:59	1.7mg/dL	01/06/2010 13:00	0.8mg/dL
12	3E			Creatinine result		01/28/2010 12:09	1.7mg/dL	01/06/2010 13:00	0.8mg/dL
13	4E			Creatinine result		01/26/2010 06:00	1.0mg/dL	07/27/2009 16:41	0.3mg/dL
14	4E			Creatinine result		01/26/2010 17:48	1.0mg/dL	07/27/2009 16:41	0.3mg/dL
15	4E			Creatinine result		01/27/2010 05:35	1.0mg/dL	07/27/2009 16:41	0.3mg/dL
16	4E			Creatinine result		01/27/2010 18:07	0.9mg/dL	07/27/2009 16:41	0.3mg/dL
17	4E			Creatinine result		01/28/2010 05:46	1.0mg/dL	07/27/2009 16:41	0.3mg/dL
18	4E			Creatinine result		01/28/2010 10:04	1.0mg/dL	07/27/2009 16:41	0.3mg/dL
19	4E			Creatinine result		01/28/2010 17:20	1.0mg/dL	07/27/2009 16:41	0.3mg/dL
20	4E			Creatinine result		01/26/2010 06:00	0.7mg/dL	01/03/2010 04:29	0.3mg/dL
21	4E			Creatinine result		01/27/2010 05:45	0.8mg/dL	01/03/2010 04:29	0.3mg/dL
22	4E			Creatinine result		01/27/2010 16:58	0.7mg/dL	01/03/2010 04:29	0.3mg/dL
23	4E			Creatinine result		01/28/2010 06:00	0.7mg/dL	01/03/2010 04:29	0.3mg/dL
24	6E			Creatinine result		01/28/2010 05:47	2.0mg/dL	06/12/2009 18:02	0.8mg/dL
25	6E			Creatinine result		01/28/2010 08:21	2.1mg/dL	06/12/2009 18:02	0.8mg/dL
26	6E			Creatinine result		01/27/2010 17:45	2.1mg/dL	01/10/2010 04:38	0.7mg/dL
27	6E			Creatinine result		01/28/2010 05:11	1.9mg/dL	01/10/2010 04:38	0.7mg/dL
28	MCY			Creatinine result		01/26/2010 05:42	0.6mg/dL	01/03/2010 05:46	0.2mg/dL
29	PI2			Creatinine result		01/26/2010 04:26	0.6mg/dL	01/16/2010 20:30	0.2mg/dL
30	PI2			Creatinine result		01/27/2010 07:00	0.7mg/dL	01/16/2010 20:30	0.2mg/dL

Ready | Records: 30 | Execute time (secs): 73.500

June Harm and Preventability

- Triggers: 212
- Adverse Events Detected: 99

- Preventability**:**
  - Preventable Adverse events: 14
  - Non Preventable : 85
- Harm and Severity:
  - Increased need for monitoring: 51
  - Need for treatment or intervention and caused temporary patient harm: 42
  - Prolonged hospitalization and caused temporary patient harm: 6

- **Voluntary incidents reported for June : 3**

Summary of All Adverse Events (09/04/07 – 06/30/10)

- Triggers: 7260
  - 32 triggers/1000 Pt days
  - 18 triggers/100 Pt admissions

- Adverse Events Detected: 1580
- Preventability
  - Preventable adverse events: 471
  - Non-Preventable: 1109
- Harm and Severity
  - Incident reached patient but not caused harm: 3
  - Increased monitoring but no harm: 376
  - Need for treatment/intervention and caused temporary patient harm: 1072
  - Prolonged hospitalization caused temporary patient harm: 129

- **Voluntary Incidents written on Same events: 54**

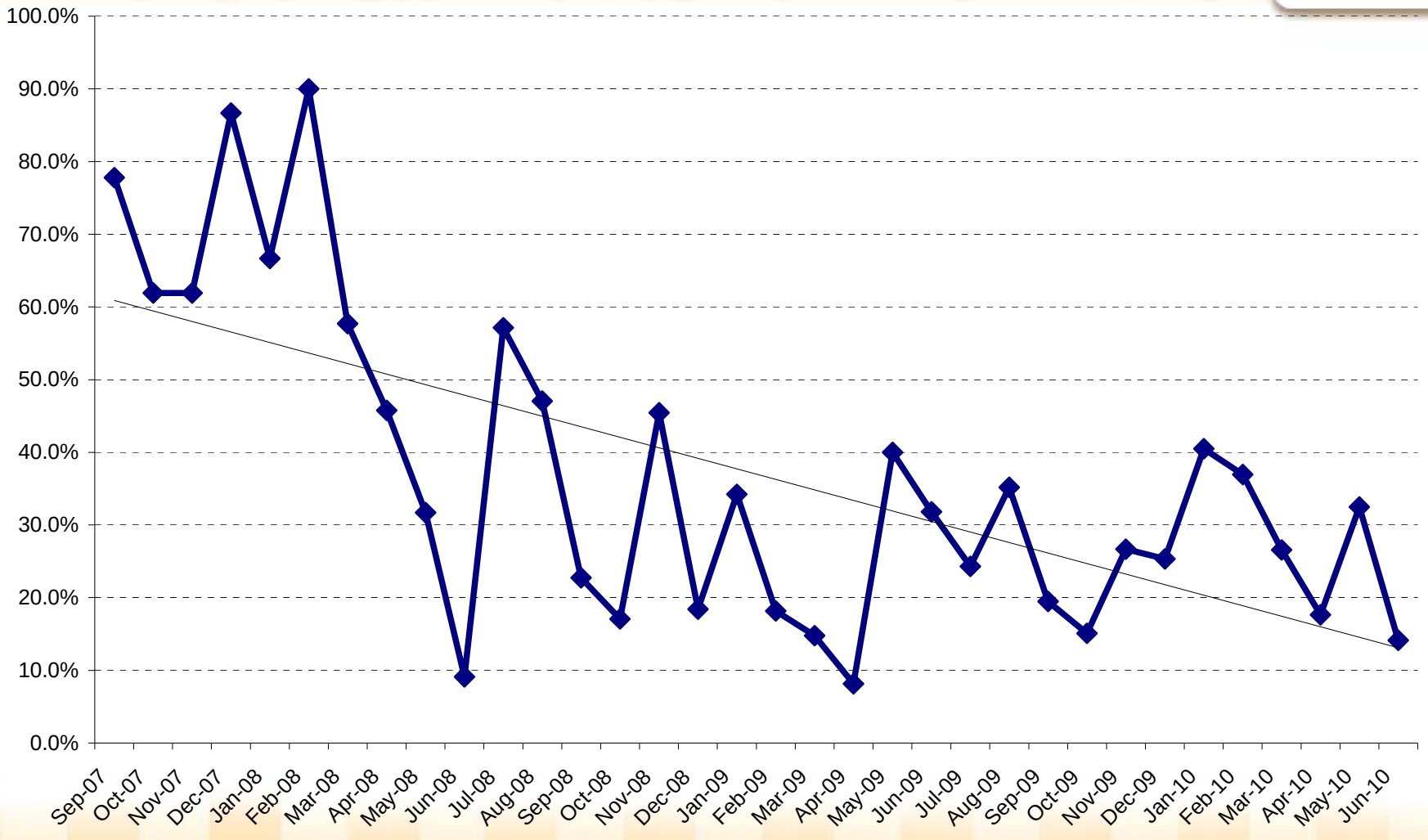
AAEDC Electronic Trigger Yield June Data

Electronic Trigger	Frequency	Adverse Events (PPV%)
Digibind	0	0
Naloxone	3	3(100%)
Protamine	2	1(50%)
Flumazenil	0	0
Hyaluronidase	1	1 (100%)
Glucose < 50 mg/dl	71	15 (21.1%)
PTT > 100 sec	14	8 (57.1%)
INR > 4.0	4	1(25%)
Anti Factor Xa > 1.5	2	1(50%)
Creatinine Doubling	67	62 (92.5%)
Bilirubin > 25 mg/dl	0	0
Transfers to the ICU	48	7 (14.5%)
Totals	212	99(46.2%)

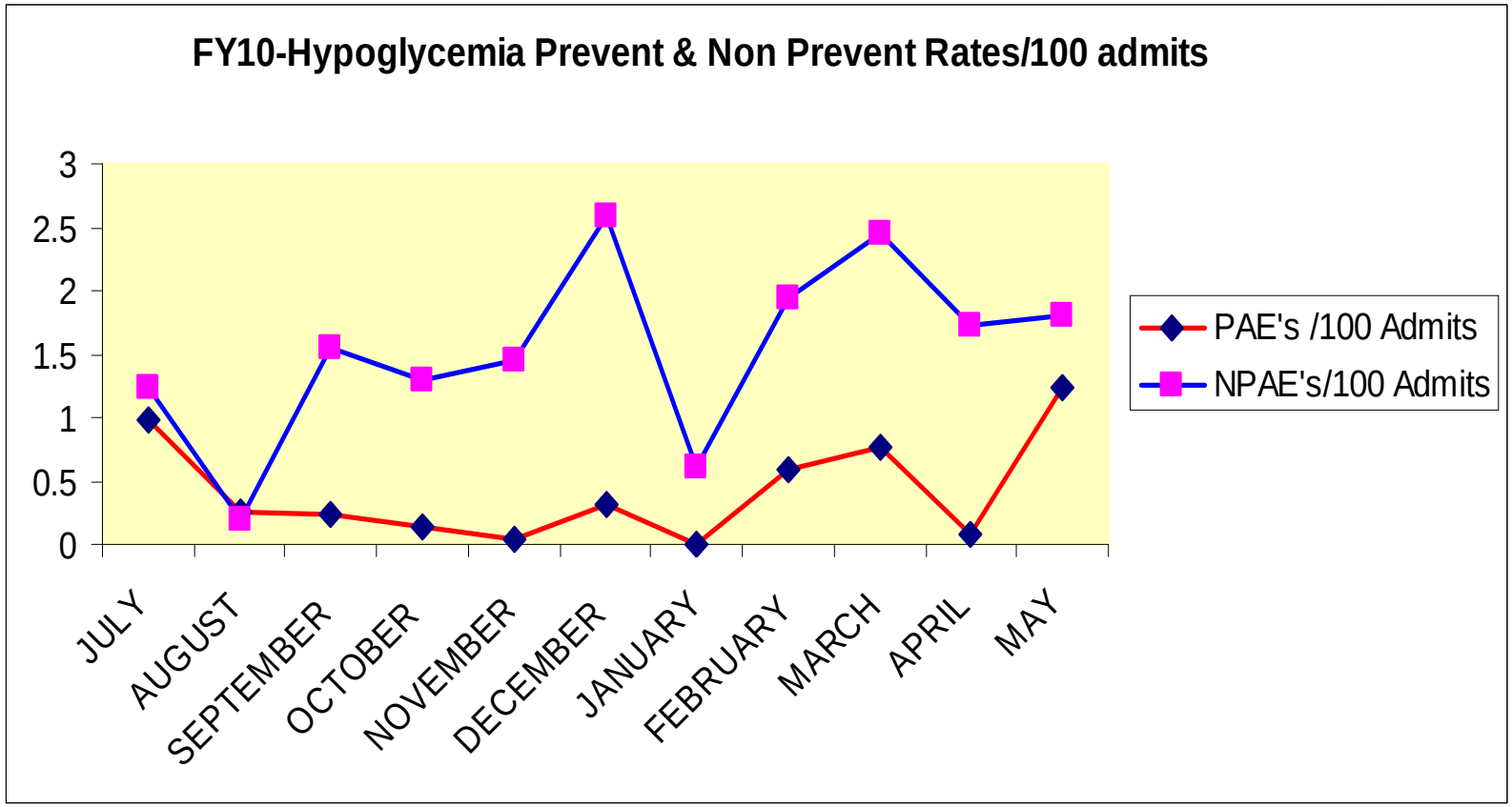
AAEDC Electronic Trigger Yield Summary Data (09/04/07- 06/30/10)

Electronic Trigger	Frequency	Adverse Events (PPV%)
Digibind	2	1(50%)
Naloxone	66	52(78.7%)
Protamine	59	5(8.4%)
Flumazenil	7	4(57.1%)
Hyaluronidase	23	23(100%)
Glucose < 50 mg/dL	3467	719(20.7%)
PTT > 100 sec	717	336(46.8%)
INR > 4.0	277	31(11.1%)
Anti Factor Xa > 1.5	4	3(75%)
Creatinine Doubling	333	106 (31.8%)
Bilirubin > 25 mg/dL	6	0
Transfers to the ICU	1117	232(20.7%)
Retired: iCal; K+; Kayexalate	1182	68(5.75%)
Totals	7260	1580(21.7%)

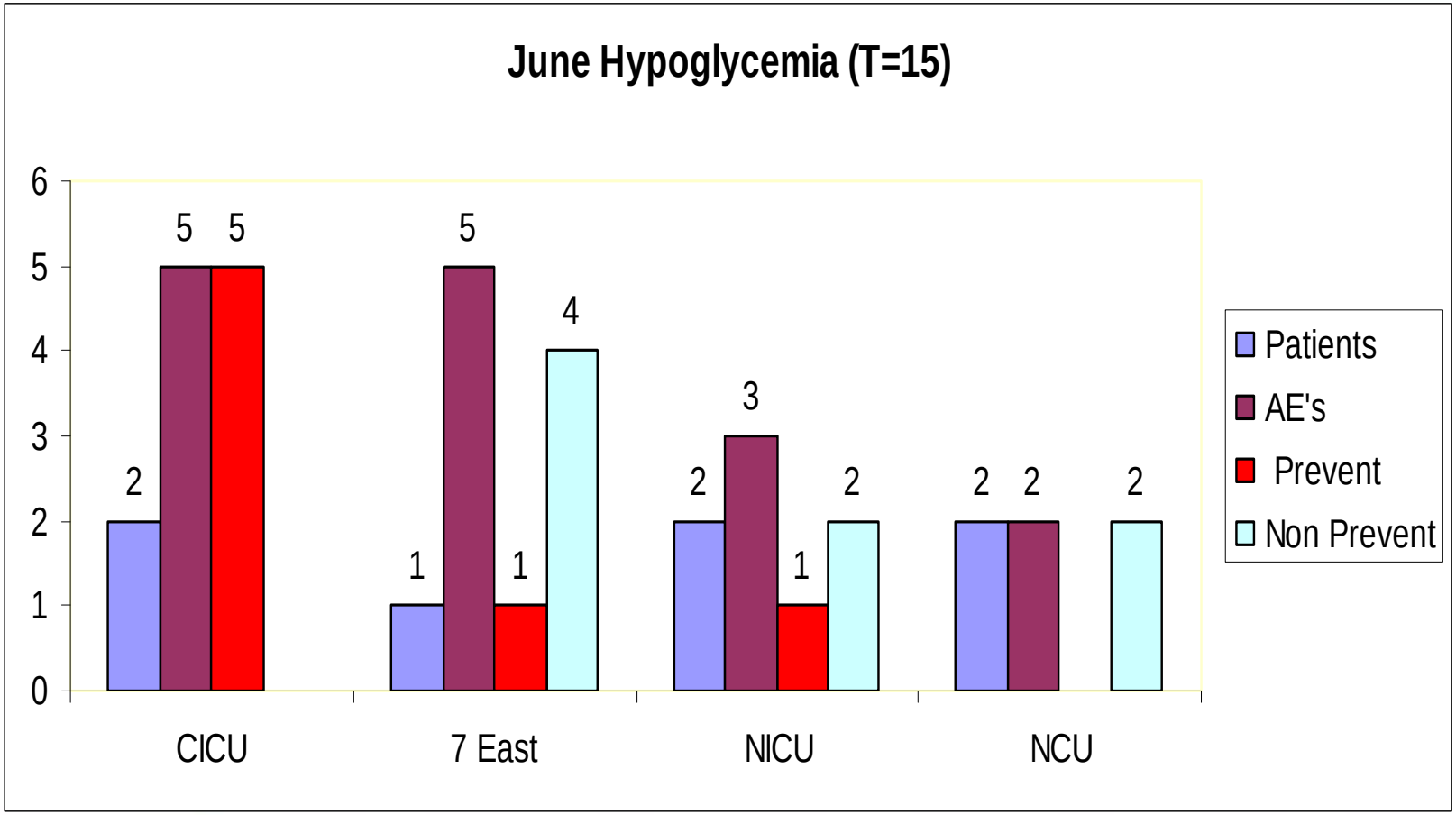
Preventable Events/Month (%)



FY10-Hypoglycemia Rates/100 Admissions



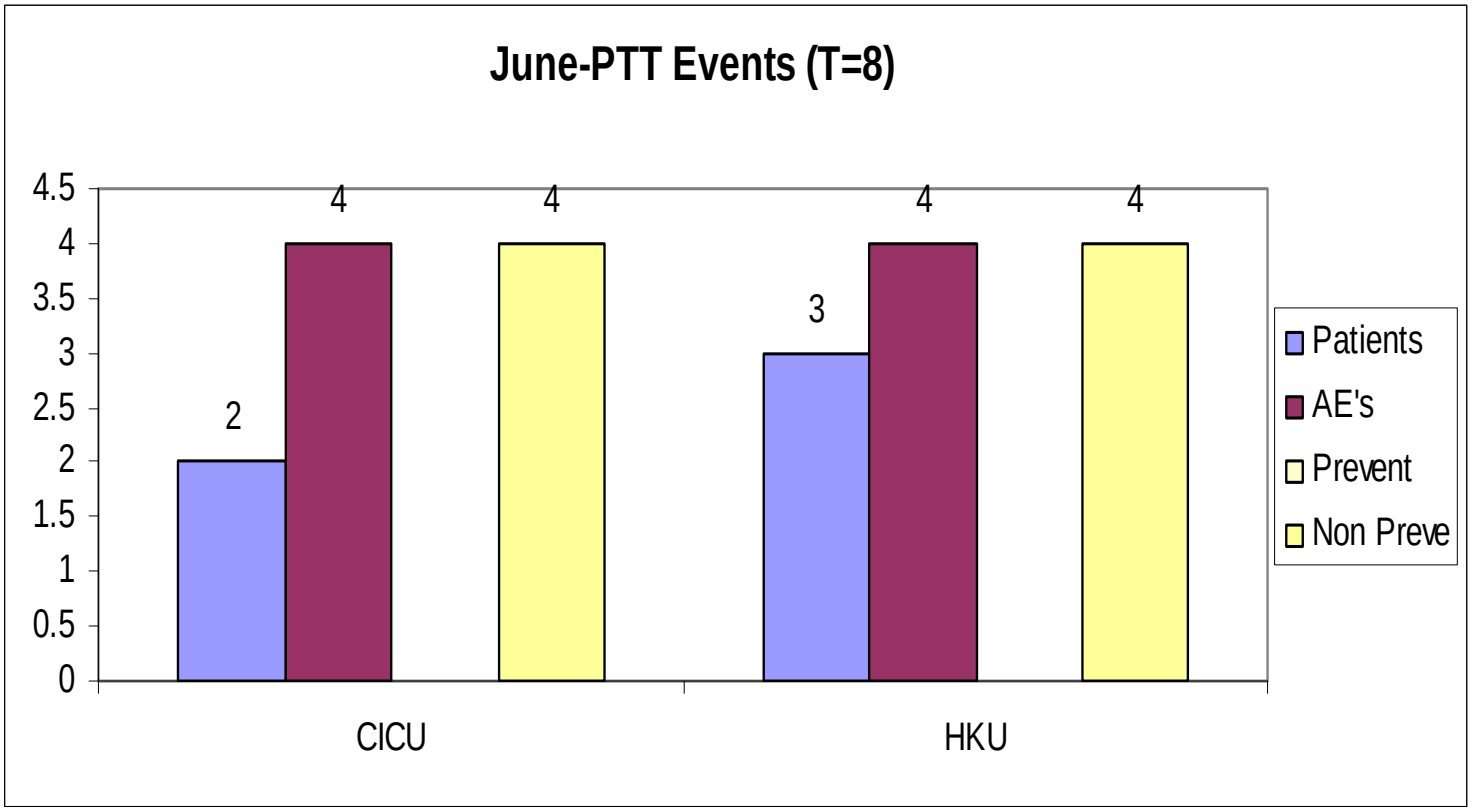
June - Hypoglycemia



June-Hypoglycemia

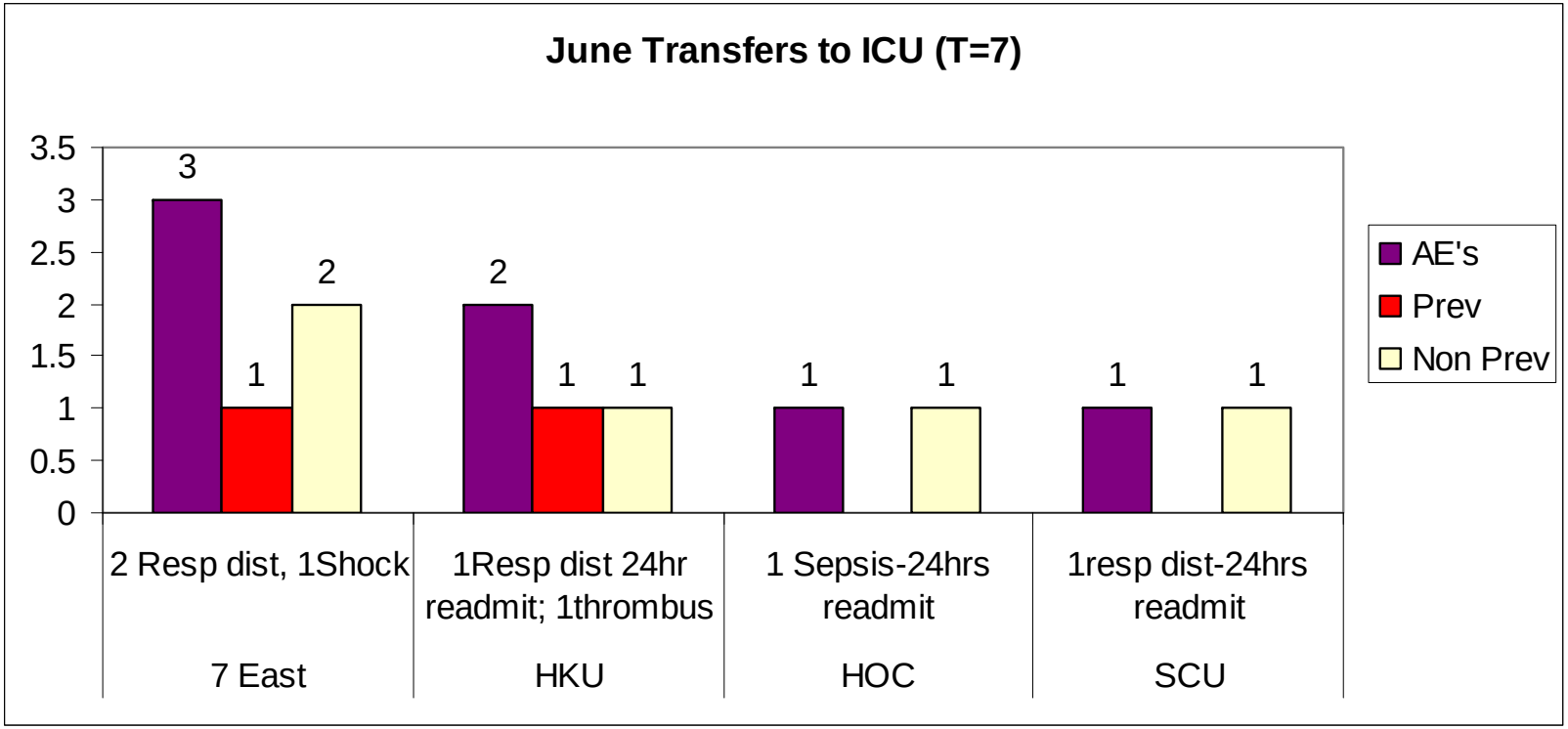
UNIT	PREVENTABLE (7)	NON PREVENTABLE (8)
CICU-5	5 - Post op Hypoglycemia	
7East-5	1 NPO for surgical procedure – Insulin	4 Insulin induced-SS protocol followed
NICU-3	1 Insulin drip infusing- PICC out	2 Hypoglycemia despite TPN infusing
NCU-2		2 Ketogenic diet

June PTT Events (T=8)

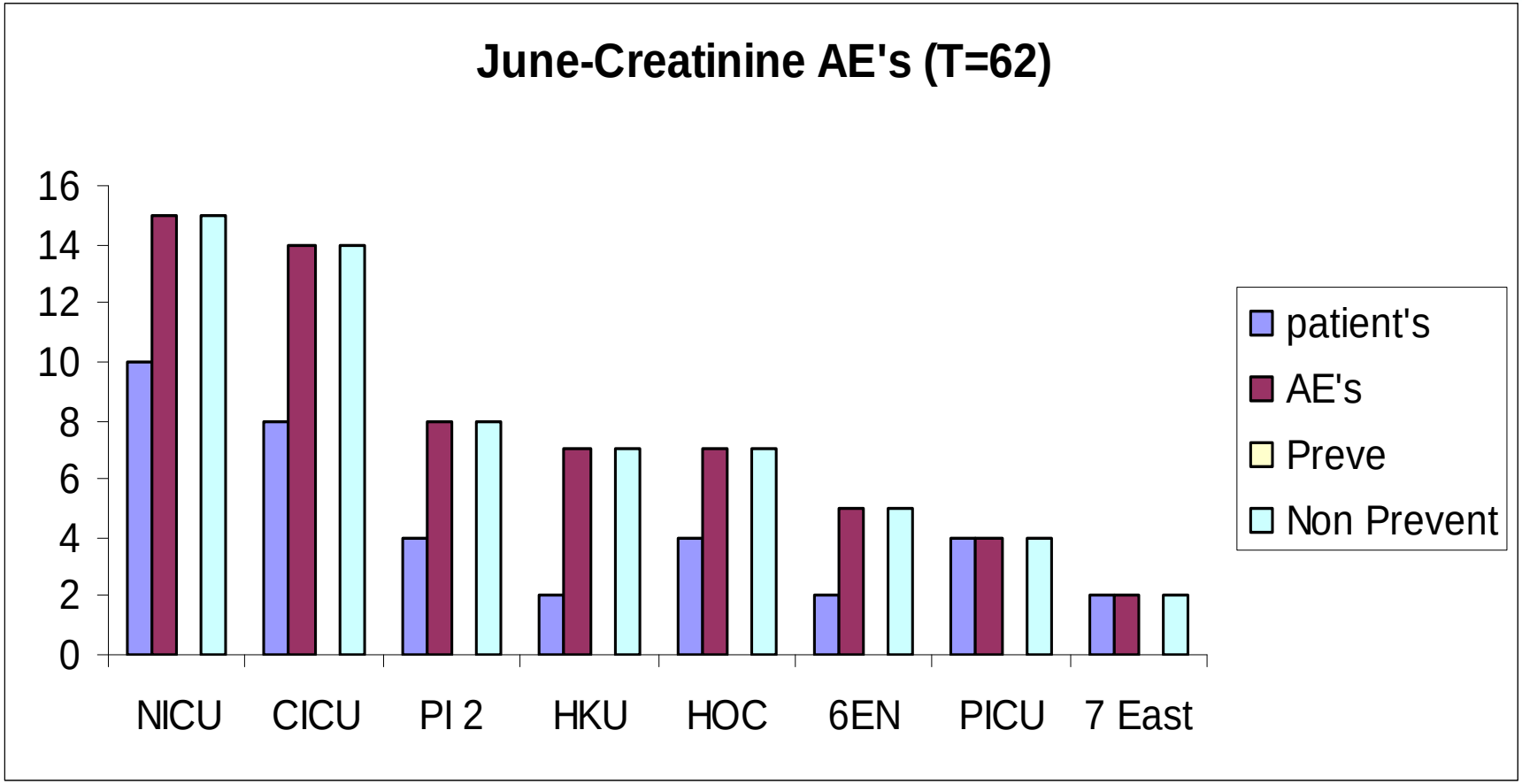


Transfers to ICU (T=7)

Transferred within 12 hrs of admission(3) & ICU Readmissions in 24 hrs (4)



June - Creatinine 0.6 (T=62)



Electronic Trigger	Associated Groups
Digibind	**Units identified as appropriate**
Naloxone	**Sedation Committee** **Units identified as appropriate**
Protamine	**Anticoagulation Task Force** **Units identified as appropriate**
Flumazenil	**Sedation Committee** **Units identified as appropriate**
Hyaluronidase	**Units identified as appropriate**
Glucose < 50 mg/dL	**Endocrinology** **Units identified as appropriate**
PTT > 100 sec	**Anticoagulation Task Force** **Units identified as appropriate**
INR > 4.0	**Anticoagulation Task Force** **Units identified as appropriate**
Anti Factor Xa > 1.5	**Anticoagulation Task Force** **Units identified as appropriate**
Creatinine doubling	**Nephrology** **Radiology (Contrast Cases)** **Units identified as appropriate**
Bilirubin > 25 mg/dL	**Neonatology**
Transfers to the ICU	**Units identified as appropriate**

Reporting Structure

Actions Performed (2007-2010)

- After incidents of hypoglycemia and trends identified, insulin use and glucose variability presented to NICU physicians and nurses
  - New Insulin Protocol implemented as a result of the presented information
- Frequent events noted with over sedation during NICU PICC Placement and subsequent Narcan use, these findings were presented to the physician leadership
  - Currently with less events
- Trends identified with increased Narcan administration in patients using PCAs.
  - Complete review of the PCA ordering process, nursing practices and improved monitoring of clinical outcomes.
  - This comprehensive analysis and subsequent interventions appears to have resulted in less events

Actions Performed (2007-2010)

- All inpatient units receive monthly reports on adverse events
  - Several interventions in floor admission criteria reviewed to improve appropriate placement of patients to the appropriate unit for their illness severity
    - Seizure floor admission criteria
    - Bacterial meningitis floor admission criteria
    - Electrolyte repletion floor admission criteria
    - Asthma floor admission criteria Asthma patients : Question raised regarding the safety of continuous nebulization in children under age 5 years
    - Program was able to identify few children older than 2yrs old with asthma transferred to PICU soon after admission
    - Reviewing the data allowed patients older than 2 years to receive continuous Albuterol in a non-ICU setting

Actions Performed (2007-2010)

- After identifying hyperkalemia as a result of ongoing potassium supplementation while on potassium wasting medications (amphotericin and its various forms as well as loop and thiazide diuretics). Once the potassium wasting medication was discontinued, often the potassium supplements were inadvertently continued resulting in hyperkalemia
  - Alerts created to identify this situation to the provider and avoid hyperkalemia

- Hypercalcemia trends identified in premature neonates receiving TPN
  - Resulted in closer monitoring of dosing by NICU dieticians
- Hypercalcemia trends identified in post operative cardiac neonates
  - Lower dosing of calcium supplements when coming off of cardiac bypass

- Anticoagulation Triggers have been implemented to address NPSGs
  - These triggers are reviewed by a multidisciplinary team to identify trends and areas for improvement.
  - CICU PICU HKU were presented on the protocol for heparin drip, sample obtaining procedure, and appropriate timing of Hematology consult.

Actions Performed (2007-2010)

- Actual real time interventions when the AAED Coordinator has alerted clinical team to an adverse event on their patient
  - Potentially dangerous INR value not recognized by clinical team and AAEDC Coordinator's contact allowed caregivers to hold coumadin dose
  - Nursing administration error identified in coumadin patient leading to increased INRs. AAEDC Coordinator's intervention gave and explanation for high INR values and allowed for improvement strategies in administration.
  - AAEDC Coordinator identified Narcan event not documented on MAR with a Code Blue Event. Documentation intervention with relevant parties
- Creatinine Trigger investigation involving unit based pharmacist notification with rise in creatinine for close watch on nephro toxic drugs.
- Interventions on process with Dextrose infusion along with Amphotericin infusion to prevent hypoglycemia.

Collaborative Participants

- **Cerner**
- **FDA**

- **Children’s Hospital and Clinics of MN**
- **Children’s Hospital, Denver**
- **Children's Hospital Los Angeles**
- **Children’s National**
- **Children's Mercy Hospital**
- **Cincinnati Children's Hospital**
- **Duke University Health System**
- **Helen DeVos Children's Hospital**
- **King’s Daughters Medical Center**
- **Lucile Packard Children's Hospital**
- **OLOLRMC Children’s Hospital**
- **Seattle Children’s Hospital**
- **Shriners Hospitals for Children**
- **St. Jude Children's Research Hospital**

Implementation Matrix

	Data Analysis	Implemented	Investigating
Children's Hospital and Clinics of MN		✓	
Children's Hospital, Denver	✓		
Children's Hospital Los Angeles			✓
Children's National Medical Center	✓		
Children's Mercy Hospital	✓		
Cincinnati Children's Hospital	✓		
Duke University Health System	✓		
Helen DeVos Children's Hospital			✓
King's Daughters Medical Center		✓	
Lucile Packard Children's Hospital			✓
OLOLRMC Children's Hospital		✓	
Seattle Children's Hospital		✓	
Shriners Hospitals for Children			✓
St. Jude Children's Research Hospital			✓