

# Improving Drug Diversion Detection and Prevention in Healthcare - An NIH National Study

Webinar for  
International Health Facility Diversion Association (IHFDA)

Tom Knight

June 18, 2019



# Disclosure Information

## **Disclosure of Relevant Financial Relationships**

Research reported in this publication was supported financially by the National Institute on Drug Abuse (NIDA) of the National Institutes of Health (NIH) under Award Number 1R44DA044083-01. The content is solely the responsibility of the presenter and does not necessarily represent the official views of the National Institutes of Health.

The presenter, Tom Knight, is the Principle Investigator (PI) leading this research at seven health systems across the United States, and owns stock in Invistics Corporation, the small business that received this NIH Award.

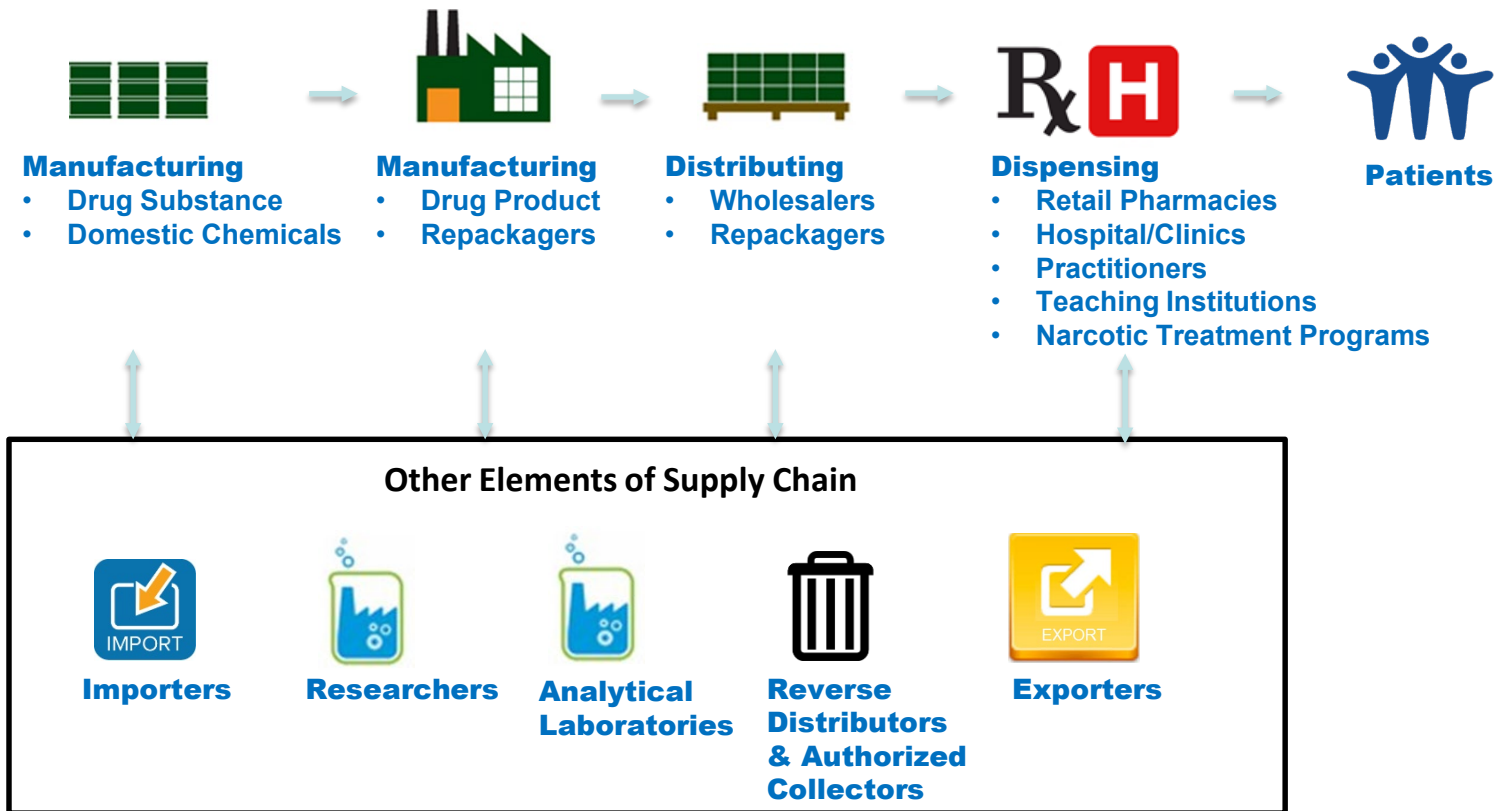
## **Disclosure of Off-Label and/or Investigative Uses**

Tom Knight will not discuss off label use and/or investigational use in this presentation.



# Pharmaceutical Supply Chain Experience

## Drug Supply Chain



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# Agenda

- Introductions
- Diversion by Healthcare Workers
  - Why it Matters
  - Challenges with Current Methods
- NIH Study: Improving Drug Diversion Detection
  - NIH Study of Improved Methods
  - Results to Date
  - Next Steps
- Questions & Answers



# How Prevalent is Drug Diversion in Healthcare?

“Rates of substance abuse and dependence are similar to those of the general population”

- 6-8% of Physicians, with higher rates for Anesthesiologists, e.g., 9.8% of Nurse Anesthetists.
- 9% of Pharmacists
- 4.7-8.8% of Registered Nurses

So for a typical, mid-size, 500 bed hospital, expect roughly 25-75 people to be diverting at any one time:

- 6-10 physicians, anesthesiologists or CRNAs,
- 4-5 pharmacists, and
- 15-60 nurses

Sources: Baldisseri, “The Impaired Healthcare Provider”  
American Nurses Association (ANA) & the National Council of State Boards of Nursing (NCSBN)



# How Prevalent is Drug Diversion in Healthcare?

## ➤ “Rates of substance abuse & dependence similar to general population”

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- 9% of Pharmacists
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## ➤ So for a typical, mid-size, 500 bed hospital, expect roughly 25-75 people to be diverting at any one time:

- 6-10 physicians, anesthesiologists or CRNAs,
- 4-5 pharmacists, and
- 15-60 nurses

## ➤ Yet most diversion is not detected, investigated, or reported

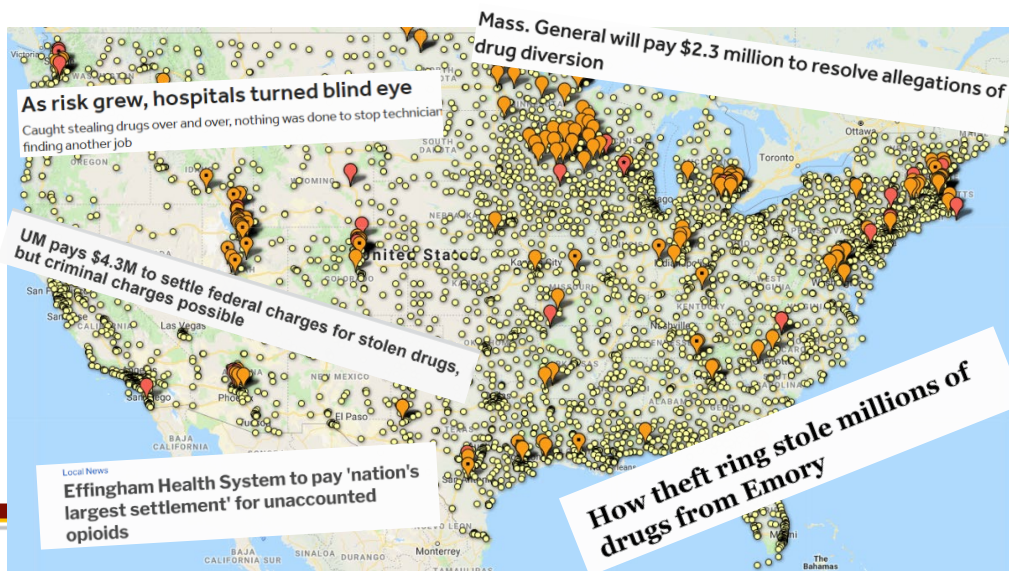
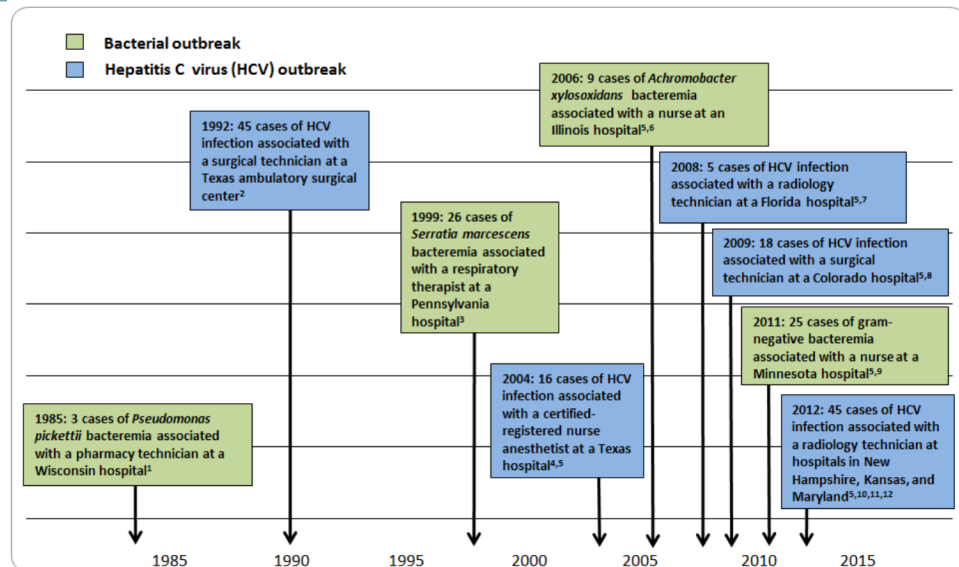
- 84% of hospitals investigated <10 cases last year
- 65% of hospitals investigated <5 cases last year

Most Diversion  
Goes Undetected...  
Until Injury or Damage Occurs



# Why We Must Improve Diversion Detection

- **Improve Patient Safety**
  - Impaired clinicians can injure patients
  - Tampering causes patient infections
- **Protect Coworkers**
  - Detect diversion and abuse sooner, before addiction spirals out of control
- **Protect Community**
  - Prevent addition and overdose deaths when stolen drugs are resold in community
- **Avoid Financial Fallout & Loss of Reputation**
  - Fines, e.g., \$4.3 million DEA fine
  - Lawsuits from injured patients
  - Damaging news coverage



Source: Invictics, as part of NIH Award Number 1R44DA044083-01, compiled from:  
 • Centers for Disease Control  
 • Inciardi, et al., The "Black Box" of Prescription Drug Diversion. J Addict Dis.  
 • 100+ articles in local newspapers and/or video segments on local TV News

# Diversion Hurts Reputations and Community Trust

**Tonight on your Local News? Headline in Morning Paper?**  
“Hepatitis C cases identified at [Local] Hospital after nurse pleads guilty to stealing patients’ hydromorphone and morphine”



Dr. Angela Dunn of CDC speaks with reporters about an outbreak of hepatitis C at [local hospital].

Source: CDC and [Standard-Examiner](#)

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# Recent Hospital Drug Diversion Cases

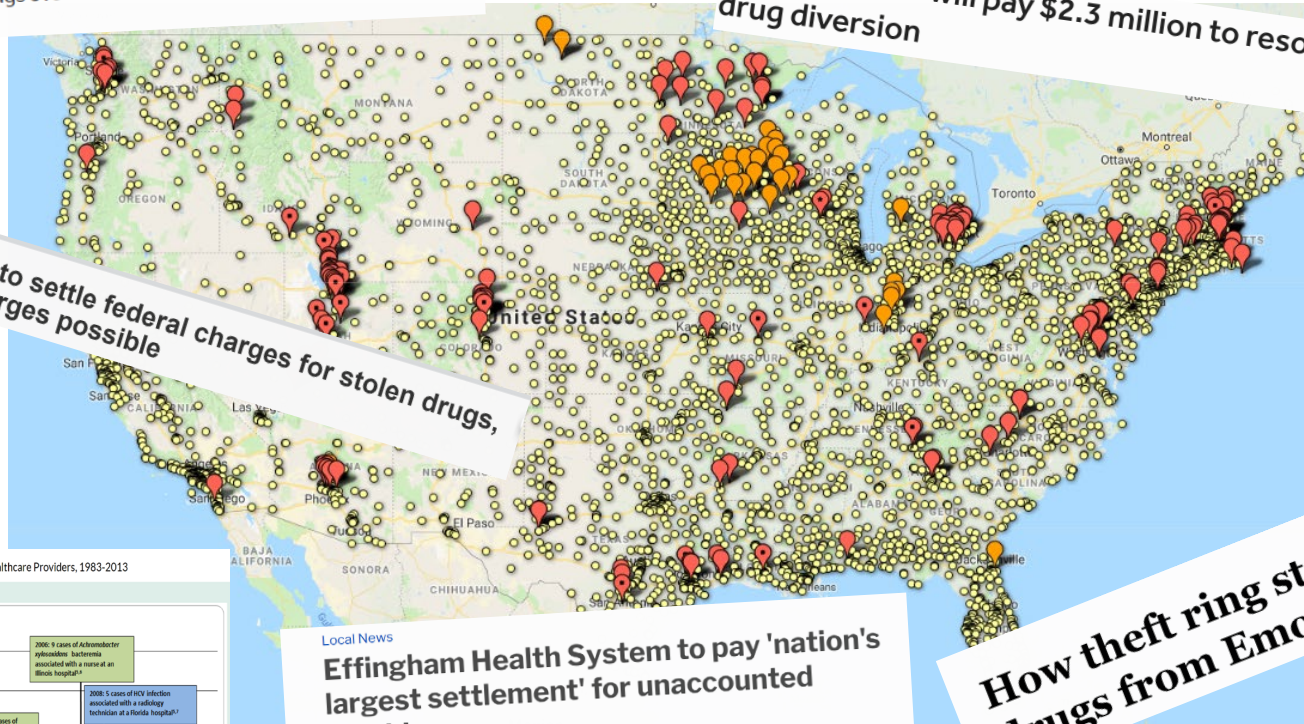
Please Visit [HealthCareDiversions.org](http://HealthCareDiversions.org)

**As risk grew, hospitals turned blind eye**

Caught stealing drugs over and over, nothing was done to stop technician finding another job

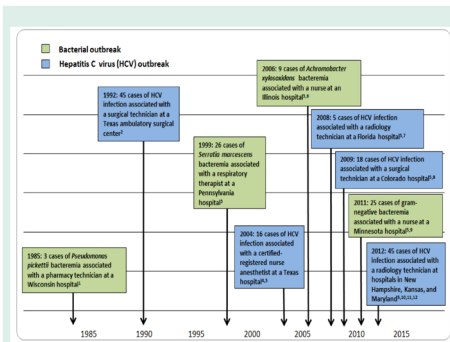
**Mass. General will pay \$2.3 million to resolve allegations of drug diversion**

**UM pays \$4.3M to settle federal charges for stolen drugs, but criminal charges possible**



**How theft ring stole millions of drugs from Emory**

U.S. Outbreaks Associated with Drug Diversion by Healthcare Providers, 1983-2013



Local News

**Effingham Health System to pay 'nation's largest settlement' for unaccounted opioids**

Source: Invistics NIH, as part of Award Number 1R44DA044083-01, compiled from:

- Centers for Disease Control
- Inciardi, et al., The "Black Box" of Prescription Drug Diversion. J Addict Dis.
- 100+ articles in local newspapers and/or video segments on local TV News



# Current Diversion Detection Technologies

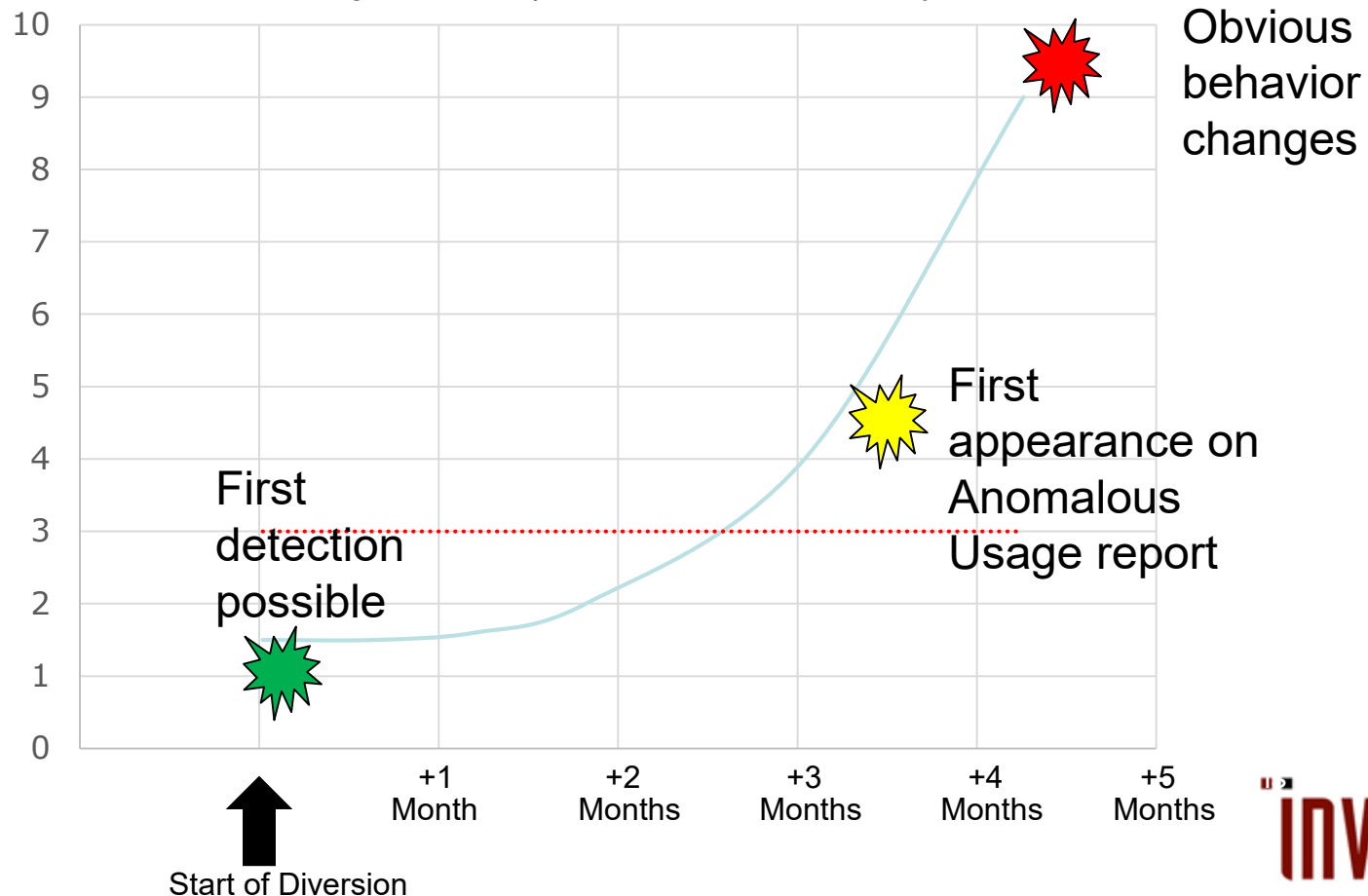
- Lock-up drugs in Automated Dispensing Cabinets (ADCs)
- React to tips, incidents, or monthly “anomalous usage” reports
- Dedicate person(s) to conduct manual investigations
- Investigations require painful reconciliation of ADC vs. Electronic Medical Records (EMR)



# The Behavior Pattern of Diversion: Detecting earlier, before patient harm or addiction tolerance

*"The biggest liability in healthcare diversion is the time between the start of diversion and the discovery of that diversion...because that is when your patients and institution are most at risk"*

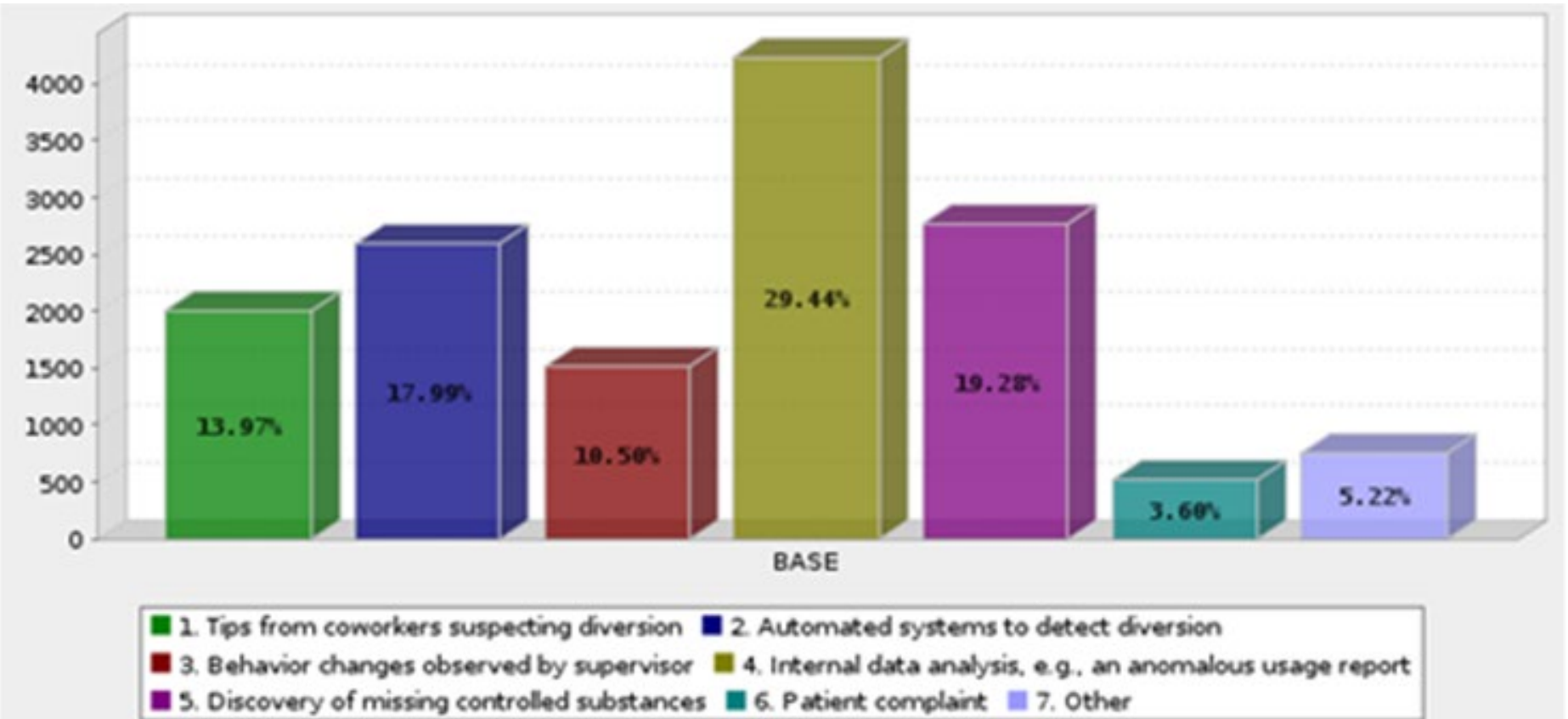
*– Russ Nix, Drug Diversion Specialist, Piedmont Health System*



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# Currently, a majority of drug diversion in US Hospitals is detected reactively using “low-tech” methods

**Q11. Within your organization approximately what percentage of drug diversion cases are initially identified via the following? Please allocate 100 points:**



# Hospitals Can't Keep Up

An investigation takes on average of 7.8 hours to complete

Investigations occur less frequently than needed

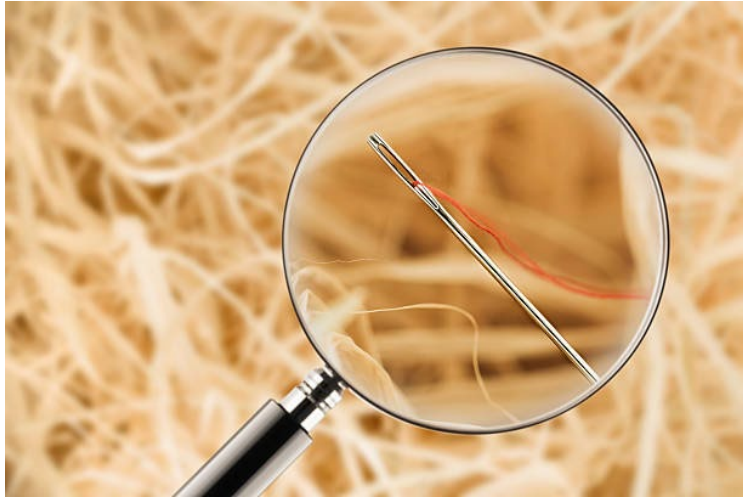
- 84% of hospitals investigated <10 cases last year.
- 65% of hospitals investigated <5 Investigations
- Even though a typical hospital would expect 25-75 people to be diverting

A majority of investigations do not confirm diversion



# Problems with Current/Competing Technology

## Don't Waste Time Looking for a Needle in a Haystack



“70-80% of our alerts are false positives, which is a tremendous resource problem for us”  
– Pharmacy Director discussing innovation challenges in this field

### Ineffective

- Fails to detect most diversion (“false negatives”)
- Most alerts are false alarms (“false positives”) => Alert Fatigue, especially for nursing & pharmacy
- Typically ignores:
  - Data available outside Automated Dispensing Cabinets (ADCs), like Pain Scales in EMR
  - Anesthesia
  - High-value medications that are not narcotics

### Inefficient

- Slow to detect
  - Lack of real-time drug monitoring
  - Anomalous Usage reports are 30 days behind
- Time-consuming to Investigate
  - Investigations are time-consuming, 8-10 hours

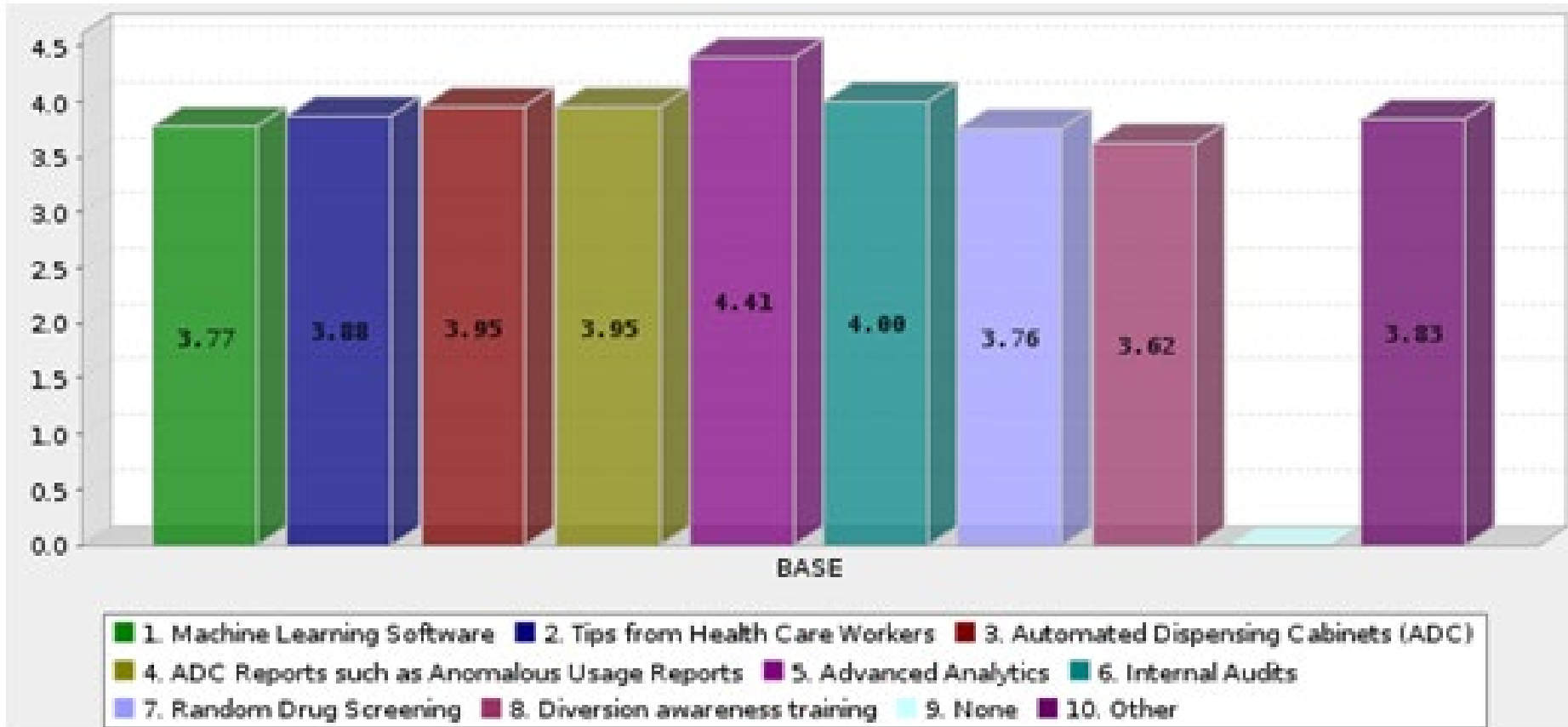
# What Can a Hospital Do?

- Ignore the problem?
- Hire more investigators?
- Look for a better way?



# Advanced Analytics was rated by HCWs as the most effective way to decrease drug diversion

**Q10. Using the scale from 1 to 5, where 1 equals not at all effective and 5 equals very effective, please rate the overall effectiveness of each item in the identification and/or preventing drug diversion.**





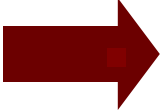
# In Summary: We Have a Problem

- Numerous surveys, the [American Nurses Association](#) (ANA) & the [National Council of State Boards of Nursing](#) (NCSBN) say approximately 10% of health care workers are dependent on drugs, consistent with U.S. population.
- Hospitals agree:
  - Diversion is occurring universally
  - Most goes undetected
  - Diversion that is detected is usually too late, after:
    - deterioration in clinical performance
    - after most of the damage to the Health Care Worker, Patient, and Hospital is already done.
- Current methods for detection are both ineffective and inefficient,
  - 84% of hospitals investigate <10 cases annually
  - Even though a typical hospital would expect 25-75 people to be diverting
- Hospitals see Advanced Analytics would be more effective and efficient

Sources: Baldisseri, "The Impaired Healthcare Provider" Critical Care Medicine Feb 2007; 35(2):S106-116  
2017 Porter Research Survey of 140 Hospitals



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# Overview of NIH Study



National Institute  
on Drug Abuse



National Science Foundation  
WHERE DISCOVERIES BEGIN

UNITED STATES  
PATENT AND TRADEMARK OFFICE



- 30 Month Study
- at 7 Hospitals
- Diversion Detection using Advanced Analytics & Machine Learning
- Expanding on research with MIT & U.S. Patent 7499766



# Support Letters from 129 Hospitals, plus Law Enforcement, Schools of Pharmacy, etc.



# Our NIH Fast-Track Study: Three Phases

## ■ Phase 1

- One Hospital

## ■ Phase 2

- Original scope: 6 Hospitals
- Funding expanded, twice: 28 hospitals to date

## ■ Phase 3

- Roll-out
- In Collaboration with State & Federal Stakeholders
  - Building a national network of healthcare diversion incidents, to prevent future diversion and its victims
- Expanding beyond hospitals to all healthcare facilities



National Institute  
on Drug Abuse

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# Focus of NIH Study for Diversion Detection



- Proactive, real-time monitoring
- Transaction integration and reconciliation of
  - all healthcare workers, and
  - all drugs at risk of diversion
  - across multiple systems and departments
- Advanced analytics and machine learning
- “Alerts” signaling suspicious or non-compliant behaviors

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# NIH Hypotheses for Scientific Study

## More Effective

- Detect diversion **sooner** (before addiction/injury)
- Detect diversion missed by current methods (as measured by fewer false negatives)

=> Lower risks to patient safety, DEA fines, etc.

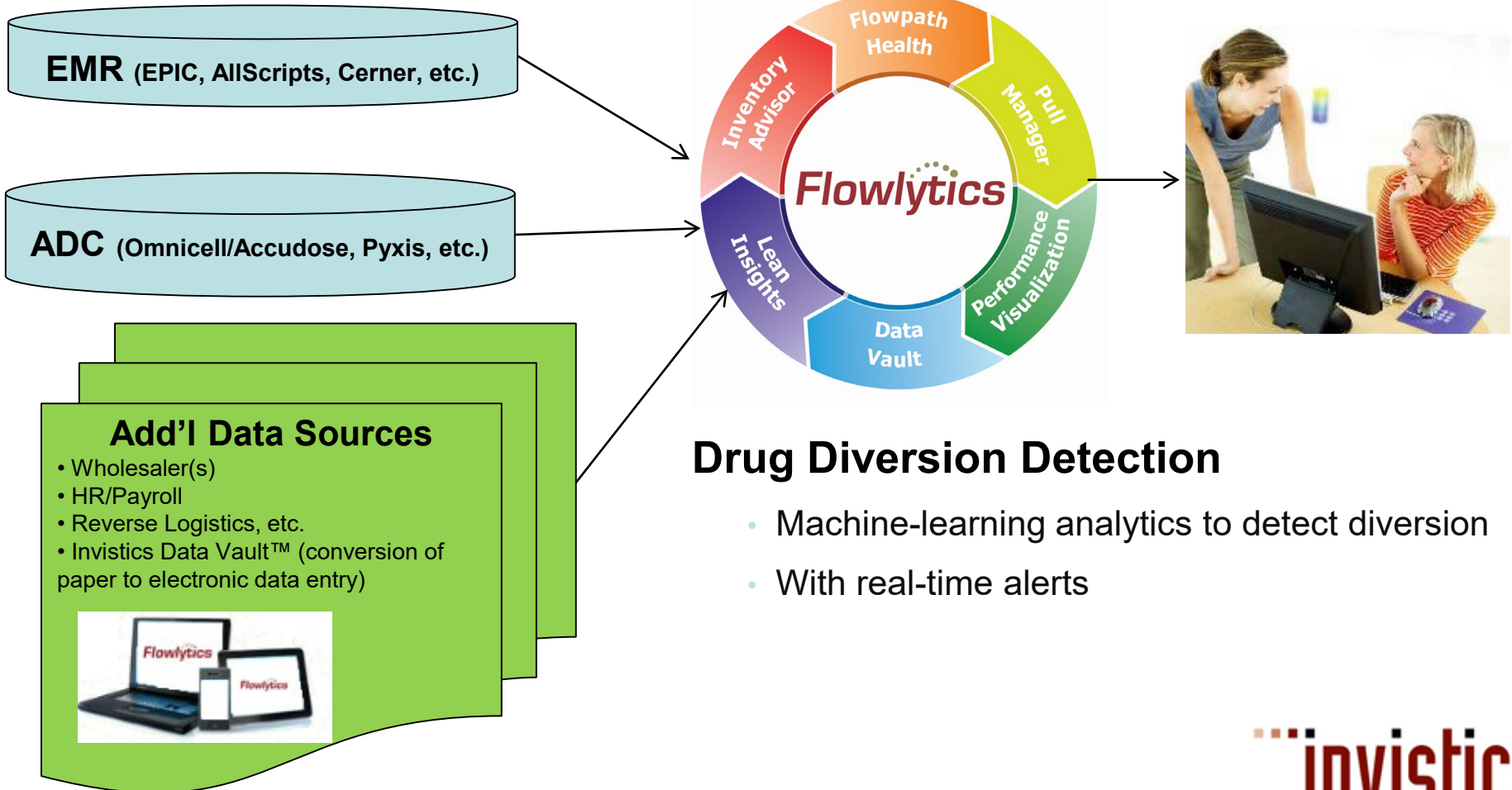
## More Efficient

- Automated reconciliation of all HCWs
- Manual investigations drop from hours to seconds (as measured by fewer false positives)

=> Lower costs to stay compliant



# Data Integration: Looking Beyond the Automated Dispensing Cabinet (ADC)





# Phase 1 Results & Case Study: Detected Diversion Earlier, with 100% Accuracy

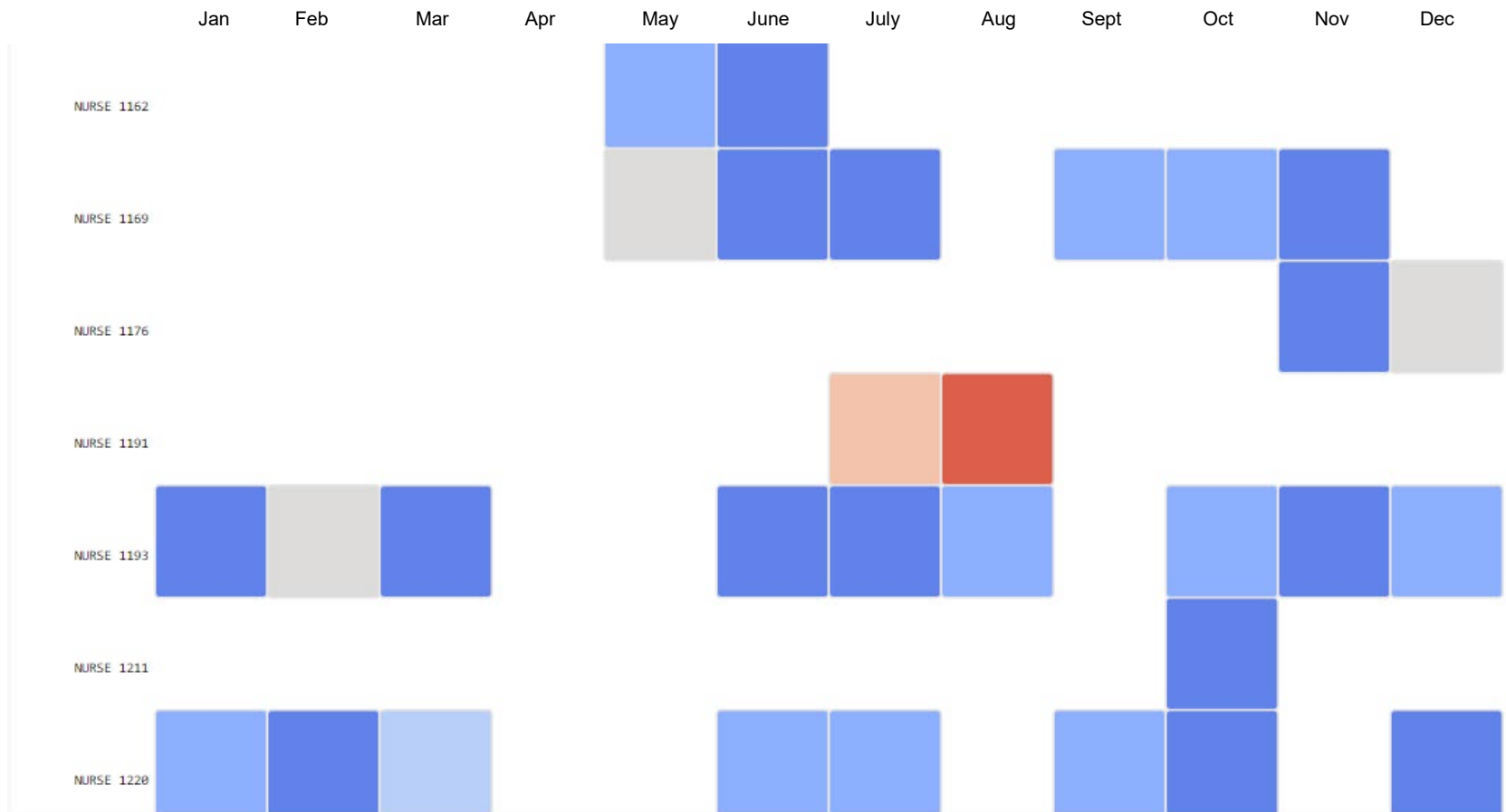
- ✓ Partnered with Piedmont Health System, with:
  - mature diversion prevention (per JC)
  - numerous “known” diversion cases
- ✓ Extracted and consolidated data & case files
- ✓ Built advanced analytics & machine learning
- ✓ Detected suspicious/non-compliant behaviors
- ✓ Detected known diversion cases in “blinded” data that had been undetected by current methods (fewer “false negatives”)
- ✓ Results:
  - 100% accuracy across 9 nursing cases
  - Every case was detected much earlier by the software
  - Notable example: diversion detected on Day #2 vs. Day #45



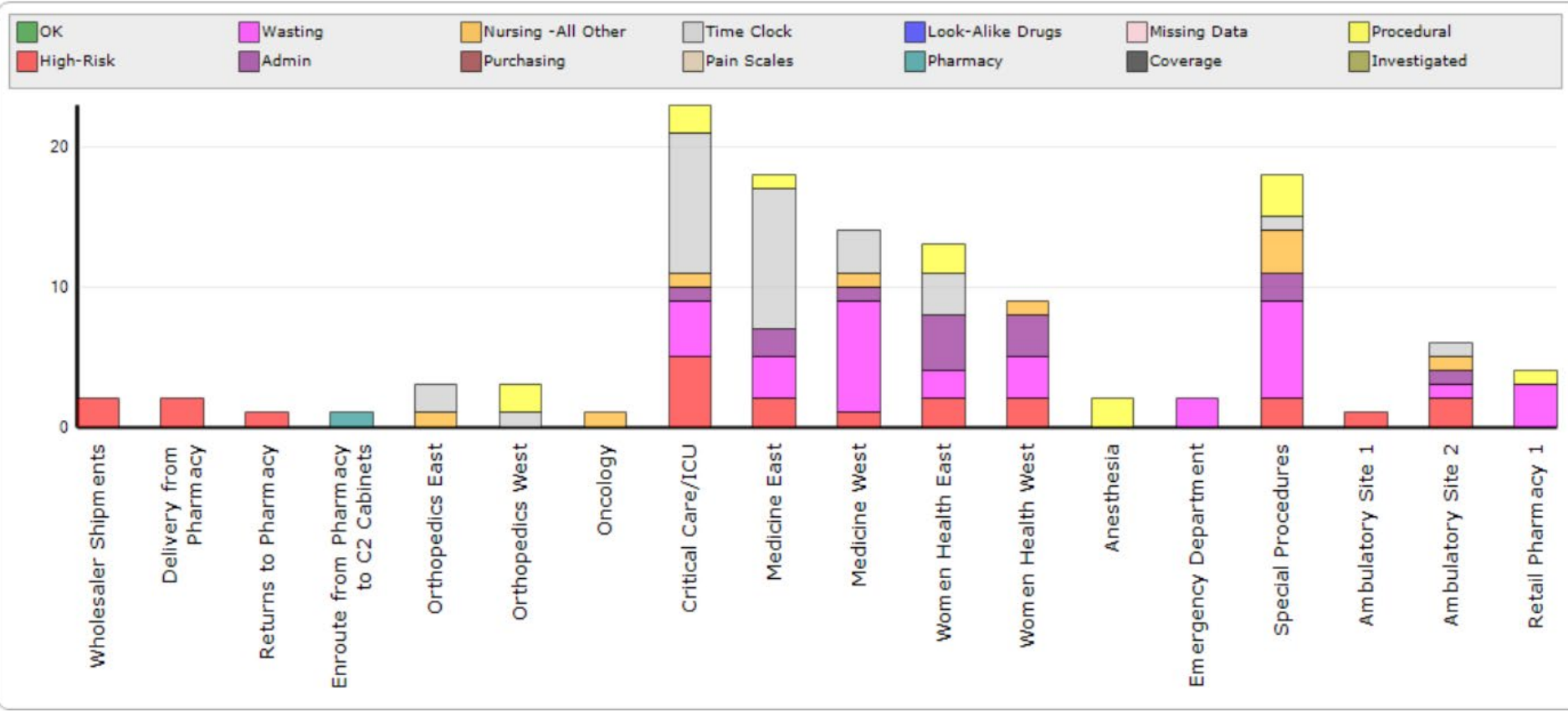
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# Phase 1 Example Case:

Nurse 1191 detected diverting first day on job, 45 days before impaired behavior was first noticed



# Diversion Detection Examples



# Diversion Detection Example

## BATCH DETAILS

Enterprise:  Controlled Substance:  Location:   
 DEA Registration:  Flow Path:  Status:

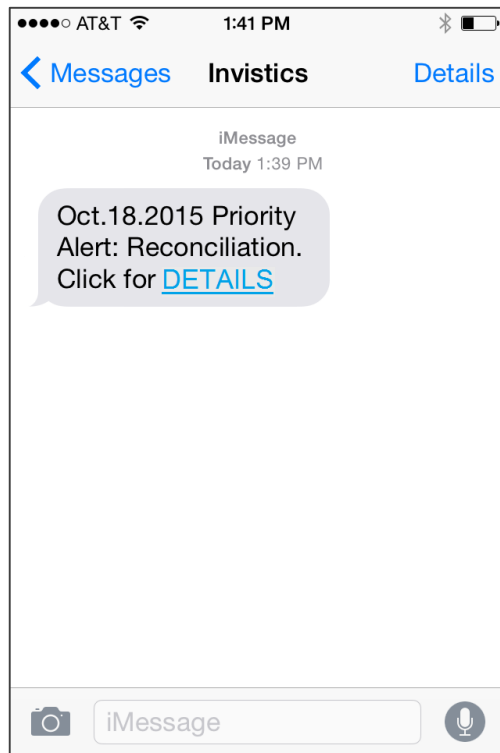
[To Excel](#) [To PDF](#)

NDC	Drug	Patient PHI	Dispensed By	Dispensed Date	Dispensed Time	Dispensed Quantity	Admin. Date	Admin. Time	Admin. Quantity	Status	Wasted Date ↓	UOM	Invest	Location
00542-5...	Fentanyl IV, 2 mcg/kg	<a href="#">LINK</a>	Nurse Smith	05/26/16	5:30 AM	4	05/26/16	5:45 AM	2	CS Accountability	05/26/16	CC	NO	Nursing Unit 4 East
00487-2...	Fentanyl IV, 4 mcg/kg	<a href="#">LINK</a>	Nurse Jones	05/26/16	4:45 AM	2	05/26/16	6:15 AM	0	Manual inventory override		CC	NO	Nursing Unit 4 East
00228-3...	Fentanyl IV, 1 mcg/kg	<a href="#">LINK</a>	Nurse Jones	05/31/16	7:00 AM	2	05/31/16	8:30 AM	1	Not Wasted within 30 min			NO	Nursing Unit 5 East
00542-5...	Fentanyl IV, 2 mcg/kg	<a href="#">LINK</a>	Nurse Willia...	05/31/16	10:00 AM	4	05/31/16	12:00 PM	2	Not Wasted within 30 min			NO	Nursing Unit 5 East
00487-2...	Fentanyl IV, 4 mcg/kg	<a href="#">LINK</a>	Nurse Smith	05/31/16	9:30 AM	3	05/31/16	2:30 PM	2	Not Wasted within 30 min			NO	Nursing Unit 5 East
00228-3...	Fentanyl IV, 1 mcg/kg	<a href="#">LINK</a>	Nurse Davis	05/31/16	11:00 AM	2	05/31/16	11:45 AM	1	Not Wasted within 30 min			NO	Nursing Unit 5 East
#434	Pump Key # 434	<a href="#">LINK</a>	Nurse Willia...	05/26/16	6:00 AM	1				Pump key not returned within 4 hrs		KEY	NO	Nursing Unit 4 East
00542-5...	Fentanyl IV, 2 mcg/kg	<a href="#">LINK</a>	Nurse Davis	05/26/16	7:00 AM	1	05/26/16	7:45 AM	0	Pyxis Count Discrep.		CC	NO	Nursing Unit 4 East
00228-3...	Fentanyl IV, 1 mcg/kg	<a href="#">LINK</a>	Nurse Smith	05/26/16	6:45 AM	3	05/26/16	9:45 AM	2	Waste not reported in 4 hrs		CC	NO	Nursing Unit 4 East



# Real-Time Alert Example e.g., for a Nurse Manager

- Highest priority alerts send a text to Nurse Manager
- Click the message to see the alert on your cell phone



Hello [xguan@invistics.com](mailto:xguan@invistics.com),

## NEW ALERTS

The following new Flowpath Health alerts have been triggered for the Acme Health System Enterprise per your notification settings:

**Initial Detection** 02/01/19 11:52  
**Alert Rule Name** High-Risk  
**Alert Rule Description** Alert to Notify When User Has a High-Risk Alert Regarding a CS-II Drug  
**Link To Item** <https://flowlytics-healthcare.invistics...>

**Initial Detection** 02/01/19 11:52  
**Alert Rule Name** High-Risk  
**Alert Rule Description** Alert to Notify When User Has a High-Risk Alert Regarding a CS-II Drug  
**Link To Item** <https://flowlytics-healthcare.invistics...>



# Advanced Analytics & Machine Learning Example

REPORTS +NEW



FILTERS FIELDS

## Drug Reconciliation Dispensing - Hospital (*Hospital Demo*)

Select Date Range:

1/1/2017  
12/31/2017

Select Location:

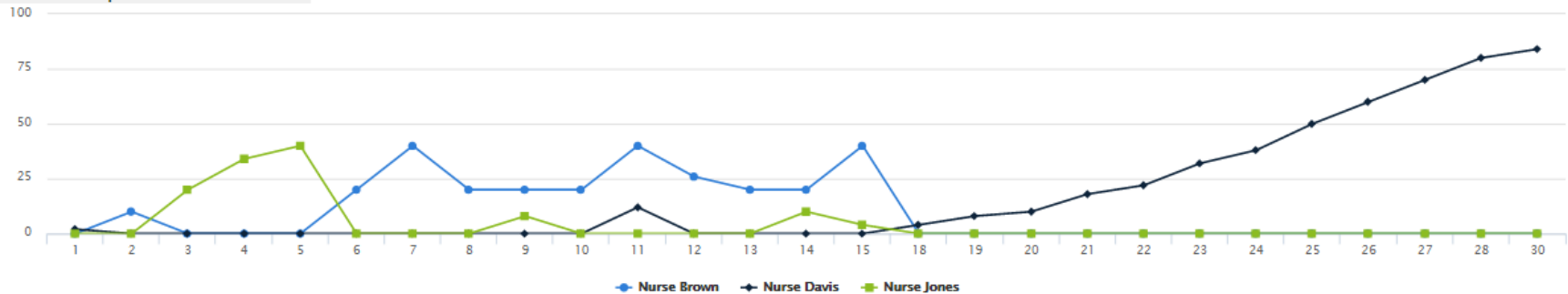
AHOSP

Select Health Care Worker:

...  
Nurse Brown  
Nurse Davis  
Nurse Jones  
Nurse Moore

UPDATE RESULTS

### Nurse Dispensed Over Time



#### ▼ Nurse Brown

DRUG	DISPENSED DATE	DISPENSED TIME	DISPENSED QUANTITY	ADMIN DATE	ADMIN TIME	ADMIN QUANTITY	WASTED DATE	WASTED TIME	WASTED QUANTITY	STATUS
Fentanyl IV, 1 mcg/kg	1/2/2017	11:00 AM		5/1/2017	11:10 AM		5/1/2017	12:00 PM	0	OK
Fentanyl IV, 1 mcg/kg	2/6/2017	10:00 AM		10/2/6/2017	10:15 AM		4/2/6/2017	10:45 AM	2	CS Accountability
Fentanyl IV, 1 mcg/kg	2/7/2017	10:30 AM		20/2/7/2017	2:30 PM		14/2/7/2017	3:00 PM	6	Late Admin
Fentanyl IV, 1 mcg/kg	2/8/2017	4:00 PM		10/2/8/2017	4:00 PM		8/2/8/2017	4:55 PM	2	OK
Fentanyl IV, 1 mcg/kg	2/9/2017	1:45 PM		10/2/9/2017	4:45 PM		6/2/9/2017	5:20 PM	4	Late Admin
Fentanyl IV, 1 mcg/kg	2/10/2017	12:00 PM		10/2/10/2017	12:00 PM		2/2/10/2017	12:55 PM	4	CS Accountability
Fentanyl IV, 1 mcg/kg	2/11/2017	2:40 PM		20/2/11/2017	2:40 PM		14/2/11/2017	3:30 PM	6	OK
Fentanyl IV, 1 mcg/kg	2/12/2017	10:15 AM		10/2/12/2017	10:15 AM		6/2/12/2017	11:20 AM	2	CS Accountability
Fentanyl IV, 1 mcg/kg	2/13/2017	10:00 AM		10/2/13/2017	4:45 PM		6/2/13/2017	5:20 PM	4	Late Admin
Fentanyl IV, 1 mcg/kg	2/14/2017	4:00 PM		10/2/14/2017	4:00 PM		6/2/14/2017	5:00 PM	4	OK
Fentanyl IV, 1 mcg/kg	2/15/2017	3:00 PM		20/2/15/2017	3:00 PM		18/2/15/2017	4:15 PM	2	OK
Fentanyl IV, 4 mcg/kg	1/12/2017	8:00 AM		3/1/12/2017	8:16 AM		3/1/12/2017	8:30 PM	0	OK

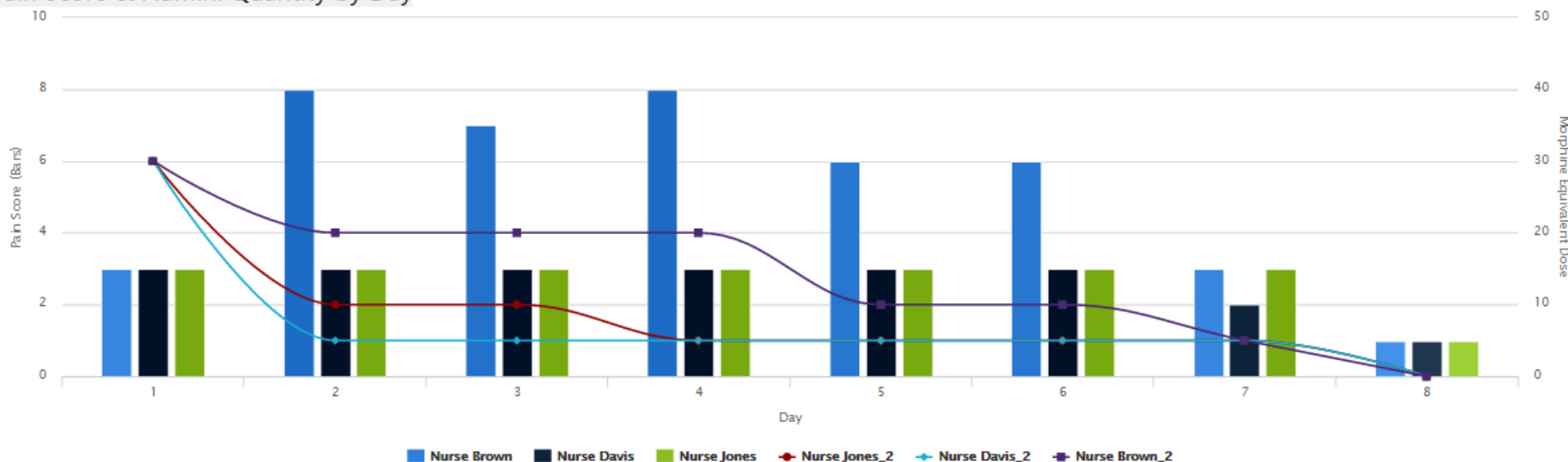
# Advanced Analytics & Machine Learning Example

## Hospital Pain Scores V2 (Hospital Demo)

PHI_EMR_# XYZ-215	DRUG ... Hydrocodone 5 MG Tablet Morphine 15 MG Oral Dosage	ADMIN_DATE <input type="text"/>	HEALTH_CARE_WORKER ... Nurse Brown Nurse Davis Nurse Jones
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UPDATE RESULTS

### Pain Score & Admin. Quantity by Day

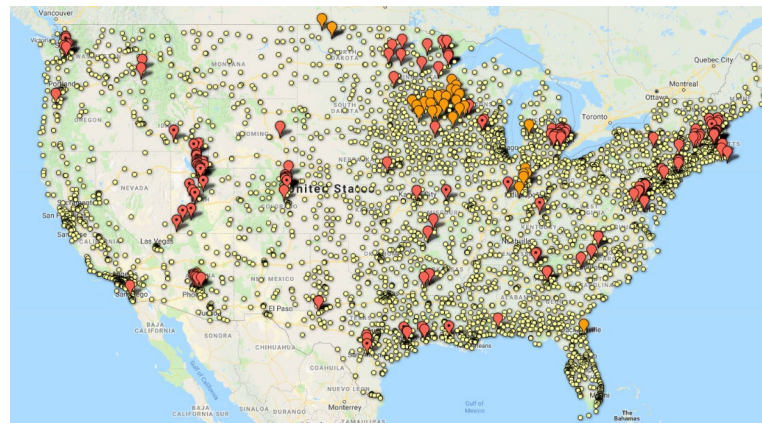


HEALTH CARE WORKER	Average Pain Score	Average Admin Quantity Per Day	Average MED
Nurse Brown	5.25	2.38	14.38
Nurse Davis	2.63	1.00	7.50
Nurse Jones	2.75	1.25	8.75

TRANS_NUMBER	HEALTH_CARE_WORKER	DIAGNOSTIC_CD	DRUG	ADMIN_DATE ▲	ADMIN_QUANTITY	MORPHINE EQUIVALENT DOSE	PHI_EMR_#	PAIN SCORE
204-1345	Nurse Brown	K44	Morphine 15 MG Oral Dosage	1/1/2017 3:00:00 AM	2	30.00	XYZ-215	3.00
204-1346	Nurse Jones	K44	Morphine 15 MG Oral Dosage	1/1/2017 9:00:00 AM	2	30.00	XYZ-215	3.00
204-1347	Nurse Davis	K44	Morphine 15 MG Oral Dosage	1/1/2017 6:00:00 PM	2	30.00	XYZ-215	3.00
204-1348	Nurse Brown	K44	Hydrocodone 5 MG Tablet	1/2/2017 3:00:00 AM	4	20.00	XYZ-215	8.00

# Phase 2 Results To Date: Detecting Diversion that was previously undetected

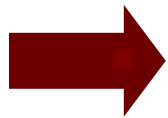
- ✓ Partnering with seven hospitals, with variety of:
  - workflows, e.g., pediatrics
  - IT health systems
  - diversion prevention policies
  - sizes and geographical locations
  - Automated, real-time data extracts & alerts
- ✓ Discovered novel innovations for risk scoring
- ✓ Rigorous confirmation of alerts as “true positives”
- ✓ Rapidly expanding coverage, e.g., NIH increased our grant twice
- ✓ Current Focus in 28 hospitals:
  - Effectiveness: Detect previously unknown diversion cases not detected using current methods (fewer “false negatives”)
  - Efficiency: Reduce “false positives” compared to current methods
- ✓ Building nationwide database of all known drug diversion incidents in healthcare
  - Launched HealthCareDiversion.org on May 1, 2019.
  - Presenting at IHFDA Annual Conference Sept 2019 in Orlando, FL





# Agenda

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  - Challenges with Current Methods
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Questions & Answers

# Questions?

- Are you interested in collaborating?
  - on this NIH study?
  - on HealthCareDiversion.org?
- Would you like to see a demo of the software?
- If so, email me at [tknight@invistics.com](mailto:tknight@invistics.com)
- We welcome questions, suggestions, and collaboration!
- Thank you,

Tom Knight

[tknight@invistics.com](mailto:tknight@invistics.com)

(770) 559-6386

