Improving Medication Practice & Patient Safety Through Artificial Intelligence

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Conflict of Interest

BD has provided support for Katelyn Hipwell’s portion of this presentation
Agenda

• Introduction & Overview
• Information Architecture (IA) to support Artificial Intelligence (AI)
• Operationalizing AI for Healthcare
• Applying AI to a real-world clinical problem: Drug Diversion
• Process improvement for Diversion Management
• Q&A
Learning Objectives

• Define Artificial Intelligence and machine learning as it applies to healthcare

• Understand the success factors necessary to optimize data analytics across information systems

• Demonstrate the use of AI/Machine Learning to address a specific patient safety & medication practice issue
Information Architecture to Support Artificial Intelligence

Scott Loebig
VP, Research & Development
BD
Information Architecture (IA) is Foundational to Succeeding in Unlocking Value through Artificial Intelligence (AI)

Ingest & centralize (virtually or physically) data assets from across your organization to solve a problem

Curate, standardize, & enrich data through people, processes, and tools to drive consistency in models that drive outcomes

Document, secure, and make data accessible to empower teams to drive new innovation with data science

On average 80% of data scientist time is collecting, cleaning, and preparing data and 20% is spent on data analysis

Source: The Cognitive Coder, Infoworld from IDG, September 26, 2017
Example: BD HealthSight™ Data Manager is a Foundational Technology to Unlock Actionable Insights

- **Customer**
- **Data Manager**
- **BD Content Team**
- **BD Library**
- **Formulary Management**
- **Reference Data**

- **EMR**

- **BD Pyxis™ Logistics v1.2**
- **BD Pyxis™ CIISafe**
- **BD Pyxis™ ES System v1.6**
- **BD Pyxis™ IV Prep**
- **BD Alaris™ System**

- 3rd party content database integration
- National reference identifier system integration

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Mapping Disparate Med IDs from Multiple EMRs to Enable Analytics

- **EMR 1**: Morphine MedID XX-XXX
- **EMR 2**: Morphine MedID YY-YYY
- **EMR 3**: Morphine MedID ZZ-ZZZ

**How much do I have?**
**Where is it located?**
**How do I manage a shortage?**

**Data Manager**
- Mapped formulary output

**Analytics**
- BD HealthSight™

**Enterprise visibility** across all facilities

- Centralized **shortage management** and redeployment
- Ability to **identify opioids across different forms**
- Ability to **match the dispense and administration** of a specific dose

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Operationalizing AI in Healthcare

Ken Tanner
Global Solutions Architect
CTO Office for Data & AI
Microsoft
Advanced Analytics Represents a Growing Opportunity

Global business value derived from **AI in 2022** will reach **$3.9T**


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# Health & Life Sciences Use Cases

<table>
<thead>
<tr>
<th>DNA sequences</th>
<th>Real world analytics</th>
<th>Image deep learning</th>
<th>Sensor data</th>
<th>Social data listening</th>
</tr>
</thead>
<tbody>
<tr>
<td>FAST-Q</td>
<td>HL7/CCD</td>
<td>MRI</td>
<td>Readings</td>
<td>Social media</td>
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<tr>
<td>BAM</td>
<td>837</td>
<td>X-RAY</td>
<td>Time series</td>
<td>Adverse events</td>
</tr>
<tr>
<td>SAM</td>
<td>Pharmacy</td>
<td>CT</td>
<td>Event data</td>
<td>Unstructured</td>
</tr>
<tr>
<td>VCF</td>
<td>Registry</td>
<td>Ultrasound</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expression</td>
<td>EMR</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Genomics and precision medicine**
- Single cell sequencing
- Biomarker, genetic, variant and population analytics
- ADAM and HAIL on Databricks

**Clinical and claims data**
- Claims data warehouse
- Readmission predictions
- Efficacy and comparative analytics
- Prescription adherence
- Market access analysis

**GPU image processing**
- Graphic intensive workloads
- Deep learning using Tensor Flow
- Pattern recognition

**IoT device analytics**
- Aggregation of streaming events
- Predictive maintenance
- Anomaly detection

**Social analytics**
- Real-time patient feedback via topic modelling
- Analytics across publication data

**Faster innovation for drug development**

**Improved outcomes and increased revenue**

**Diagnostics leveraging machine learning**

**Predictive analytics transforms quality of care**

**Improved patient communications and feedback**
Adopting Advanced Analytics in Your Organization

Where do you see your organization today?

Where do you see your top competitors today?

Where do you see your organization in the future?

Analytics capabilities

Basic  Advanced
What the Research Tells Us

Analytics capabilities

Basic  My organization Now*

Advanced

My top competitors Now*

My organization In the future (24-36 months)*

*Based on independent market research in the form of focus groups and in-depth-interviews

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How Organizations are Transforming

Serving business users and end users with intelligent and dynamic applications

Build a unified and usable data pipeline

Develop/Train ML and DL models to derive insights

Operationalize models and distribute insights at scale

AI Service Management

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But There is a Lot to Consider

Complexity of solutions
Many options in the marketplace

Data silos
Incongruent data types

Difficult to scale effectively
Performance constraints

And most aren’t satisfied with their current solutions

46% Are satisfied with ease of use of analytics software

21% Are satisfied with access to semi-structured and unstructured data

28% Are satisfied with ability to scale to handle unexpected requirements

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Opportunity Shaping – Assess & Prioritize Business Opportunities

Feasibility
- Do I have or can I get the data requisite to drive the intelligence.
- Can the AI (prediction) be delivered?

Surmountable Barriers to adoption
- Technical Implementation leveraging existing and new systems
- Business adoption of AI outcomes

SWEET SPOT
- These are the use cases that will be prioritized for implementation as part of building AI COE and gradually building analytics platform, accompanying process, organization and culture.

Significant Business value
- What business value can we derive from the solution?
- Quantifiable? How much?
Agile Data Estate Evolution over Data Field of Dreams

- Capture / Evolve your Architecture Patterns
- Capitalize on capabilities from cloud
- Leverage Your Existing Data Estate
- Align / Refine your architecture as you grow your Analytics Platform
- Prioritize Business Results
Agile, DevOps... with AI?

- Design and engineering with scale in mind
  - Choose your run AI Platform
  - Engineer for Target Run Platform
- Focus on team integration
  - AI Engineering Transition States
- AI Service Management
  - Start with monitoring
  - Build in intelligence then automation (retrain/re-engineer/retire)
Applying AI to a Real-World Clinical Problem: Diversion Analytics

W. Perry Flowers, RPh, MS
VP Medical Affairs, Enterprise Medication Management BD
Opioid Epidemic

National Public Health Emergency

Started Years (read: decades) Ago
[Science 21 Sep 2018: Vol. 361, Issue 6408]

Now Impacting Life Expectancy Calculations
[NCHS Data Brief, No. 293, December 2017]

Diversion of pharmaceutical grade product is a basic foundation of a healthcare leaders’ charge and the law with passage of the Controlled Substances Act in 1970
[United States Drug Enforcement Administration, United States Code (USC) Controlled Substances Act]
Opioid Crisis: By the Numbers

10 – 15%
Source: Crit Care Med. 2007; 35 (suppl):S106-16

$ 115 M
$ 44 M
$ 2.3 M
$ 4.3 M
Source: DOJ/DEA press releases

Staggering numbers from 2017 CDC data

- The age-adjusted rate of drug overdose deaths in the United States was 9.6% higher than the rate in 2016
- 70,237 drug overdose deaths in the USA in 2017
- 16% of U.S. counties have enough opioid prescriptions dispensed for every person in that county to have one
- The overall opioid prescribing rate dropped to 58.7 prescriptions per 100 people

Source:
- [NCHS Data Brief, No. 329, Nov 2018]
- [U.S. Opioid Prescribing Rate Maps]
Healthcare Facility Diversion

Multiple Victim Crimes

Healthcare workers & patients

Opioid User Disorder

Estimated to be costing U.S. Employers $18B per year in lost productivity and medical expenses

[Castlight Health, 2016]

Reputational Risks

Organization, profession, and person

Prevention Measures are Critical

ASHP Guidelines on Preventing Diversion of Controlled Substances, 2017, offers a thorough review of measures and controls from procurement thru to product waste and removal

[Am J Health-Syst Pharm. 2017; 74:e10-33]

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Healthcare Leadership Challenges

Education leads to awareness
Employees, Leadership, Medical Staff

- Need better analytics - and - more advanced models
- Need protected privilege for diversion transparency
- Need a safe culture for internal reporting

Opioid Stewardship creation

Prevention and Controls have to be present

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BD HealthSight™
Diversion Management Application

- Masked Healthcare Clinician to reduce bias
- Machine Learning Algorithms
- Variations in patient care within the same episode of care
- Internal investigation documentation capability within the same application

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Specific User Risk Score & Top Anomalous Behaviors View

Nurse
431
Unmask

Assigned to
Doris Ivy

Complete

Key Trends
Risk Score 2018

Anomalous Behavior
- Waste delay hydromorphone injectable
- Waste delay morphine injectable
- Dispensed morphine injectable
- Canceled transactions

History
Opened Wed, Oct 18, 2017, 13:12

Investigation R00075
Reason for Investigation:
Hey Doris, this persons risk score spiked again. They have changed to a much slower ward, but I am seeing many of the same behaviors (delays, overrides) in this new environment as I reported while there were assigned to the ICU. Sent a note to Michael to particularly watch their use of meperidine and hydromorphone injectables.

Megan Donnelly

Transactions

Prior Investigations

Time Frame
Nov 21, 2017 - Nov 21, 2017

Patient
V345678

Medication
Morphine sulfate injection, +3 ...

Issue
All

Sort
Dispense Time

Station Name
1EastBlueA + 2 others
Process Improvement for Diversion Management

Katelyn Hipwell, PharmD, MPH
Pharmacy Clinical Operations Manager
Department of Pharmacy Services
University of Virginia Health System
UVA Demographics

- Tertiary care academic medical center
- 612 Beds
  - 494 Average Daily Census
  - 28,359 Inpatient Admissions
- 64,780 ED Visits
- 878,781 Outpatient Visits
- Level 1 Trauma Center
- Comprehensive Transplant and Stroke Center
- Nationally recognized Cancer and Heart Center

2018 statistic data
Major Areas of Concern for Diversion

- 8,119 Full-time Equivalents (FTE)
- 526,610 Annual Controlled Substance Transactions*
- Automated Dispensing Cabinets (Pyxis ES)
  - 141 Medstations
  - 66 Anesthesia Stations
- Electronic Medical Record Epic

UVA

Documentation Requirements
Reporting
Surveillance
Investigation
Record Keeping
Chain of Custody
Healthcare Providers
Patients
Support Staff
Family & Caregivers
Accessibility
Human Resources

#HIMSS19
Current Controlled Substance Audit Process

Background:

• Team members that handle controlled substances (CS) are compared to team members from the same practice area whose administration data shows ≥ 2+ SD higher than team members on the unit

• Completed on a monthly basis

- CII Safe Report
  - 1 hour

- Tracking and Trending Excel Spreadsheet
  - 2 – 4 hours

- Random Selection of Flagged Team Members
  - 1 hour

- Pyxis Transaction Evaluation
  - 16 hours

- Investigation Template Creation
  - 8 hours

- Nurse Leadership Epic Evaluation based on Pyxis Transactions
  - 0.5 – 2 hours

- Investigation Progress Tracking, Review, and Reminders
  - 8 hours

- Completed or Warrants Further Investigation
  - 0 – infinite hours

40 – 44+ hours/month
# Surveillance Audit Template

Sections of Template

- **Blue** = Pyxis Activity Log
- **Yellow** = Documentation Assessment – Epic
- **Orange** = Pain Assessment – Epic
- **Green** = Assignment Assessment

<table>
<thead>
<tr>
<th>Number of Issues</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.6%</td>
<td>Documentation Practice</td>
</tr>
<tr>
<td>8.9%</td>
<td>Multiple discrepancies/More reports to audit</td>
</tr>
<tr>
<td>3.8%</td>
<td>Override Practice</td>
</tr>
<tr>
<td>7.6%</td>
<td>Owner of audit</td>
</tr>
<tr>
<td>32.9%</td>
<td>Did not complete</td>
</tr>
<tr>
<td>15.2%</td>
<td>Pain Score</td>
</tr>
<tr>
<td>1.3%</td>
<td>Wrong Patient</td>
</tr>
<tr>
<td>21.5%</td>
<td>Wasting Practice</td>
</tr>
<tr>
<td>1.3%</td>
<td>Wrong Frequency</td>
</tr>
<tr>
<td><strong>100.0%</strong></td>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>
Pain Points
Challenges vs. Enhancements

### Current Limitations

1. Not specific to patient care type
2. Limited comparison by Pyxis machine
3. Manually tracking in excel spreadsheets
   - a. Investigation transactions
   - b. Quality assurance trends
   - c. Trends
   - d. Receipt, Completion, Actions
4. High rate of false positives
5. Data Assessment
   - a. Manual monthly intervals
6. Traveler staff leave before detection
7. Communication and investigation completion
   - a. Emails

### BD HealthSight™ Improvements

1. Evaluation based on machine learning
2. Compares similar patient types regardless of Pyxis machine
3. All tracking is automated and completed within the tool
4. Potential to decrease false positives
   - a. Determine post-implementation
5. Data Assessment
   - a. Updated and available daily
6. Timely traveler staff detection
7. Communication and investigation completion
   - a. Located in tool
# UVA Controlled Substance Metrics

<table>
<thead>
<tr>
<th>Measure by Priority</th>
<th>Frequency</th>
<th>Reported Metric</th>
<th>Expected Changes</th>
</tr>
</thead>
</table>
| **Unreconciled Dispenses**          | Nursing – Daily Pharmacy – Daily Reported – Monthly | % = Unreconciled CS ADC Dispenses/ All CS ADC Dispenses                          | • Ability to assess daily  
• % trend down                                                                         |
| **Unresolved Discrepancies > 24 hours** | Nursing – Daily Pharmacy – Weekly Reported – Weekly | % = CS Discrepancies unresolved > 24 hours/All CS Discrepancies  
% = CS Discrepancies/All CS ADC Transactions | • Maintain                                                                   |
| **Undocumented Waste**              | Nursing – Daily Pharmacy – Weekly Reported – Weekly | % = CS Not Wasted/All CS Waste Transactions                                      | • Ability to assess daily  
• % trend down                                                                         |
| **Overrides**                       | Nursing – Daily Pharmacy – Weekly Reported – Monthly | % = Override CS ADC Dispense/All CS ADC Dispenses  
% = Linked Override CS ADC Dispense to Order/All Override CS ADC Dispenses          | • Increase in resolution of unlinked overrides  
• % trend down                                                                         |
| **Time to Administration**          | TBD                                            | Minutes = Time CS Dispensed from ADC to Administration Charted  
Minutes = Time CS Dispensed from ADC to Wasted if applicable | • Start consistently measuring  
• Establish baseline                                                                     |
Questions

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