(BIG) DATA DRIVEN ANALYTICS: Enhancing Emergency Healthcare

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## Why Big Data Analytics/Technologies?

### Domains of Interest to Private Sector

<table>
<thead>
<tr>
<th>Domain</th>
<th>Interest Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer transactions</td>
<td>73%</td>
</tr>
<tr>
<td>Customer/prospect data</td>
<td>56%</td>
</tr>
<tr>
<td>Market &amp; competitive data</td>
<td>49%</td>
</tr>
<tr>
<td>Service data</td>
<td>49%</td>
</tr>
<tr>
<td>Warranty &amp; fraud detection</td>
<td>49%</td>
</tr>
<tr>
<td>Channel data</td>
<td>44%</td>
</tr>
<tr>
<td>Product data</td>
<td>34%</td>
</tr>
<tr>
<td>Industry specific data</td>
<td>24%</td>
</tr>
<tr>
<td>Supply chain data</td>
<td>12%</td>
</tr>
</tbody>
</table>

### My Experience

- U.S. Department of Veterans Affairs
- Publishers Clearing House
- SiriusXM
- Urban Science
- Delphi
- LGV
- Magna
- General Dynamics
- Faurecia
- Traffic
- TARDEC
- GM
- DFoundry
- Ford
- Delphi
- MRF

**Source:** NewVantage Partners, Big Data Executive Survey 2012-2018 & HBR.org
Case Study: Enhancing Emergency Healthcare

- **Current State:** Ineffective service and a national crisis!

  - **Opportunity:** Growing adoption of EHR systems in Hospitals

- **Approach:** Data and AI to improve “real-time operational intelligence” for enhanced “proactive orchestration” of healthcare operations!

```
Year: 2008
Adoption: 9%

Year: 2011
Adoption: 28%

Year: 2015
Adoption: 84%
```

Medical Errors: 250k Deaths/Yr
76% due to Information Processing / Verification


Data Source: CMS / Propublica.org Data Span: 2016

- Median Time for Admission: 5.5 hours
- Median Patient “Boarding” Time: 2.25 hours

```
Data Source: CMS / Propublica.org
```

Median Boarding Time (Admitted Patients) in Minutes
Median Time Until Sent Home in Minutes (Discharged Patients)

ED Visits (Millions)
Number of EDs

Year: 2008
Adoption: 9%

Year: 2011
Adoption: 28%

Year: 2015
Adoption: 84%

ED Visits
Emergency Departments

2015: 136.9 Million Visits (CDC)

```
```

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```
Typical ED Care Giving Process

- **Main driver of overcrowding**
- **48% of ED length of stay**
- **CMS requiring boarding stats (2014)**

- **“BOARDING DELAY” FOR ADMITTED PATIENTS**
- **258 mins**

- **Time Stats from Henry Ford Hospital (May 2014 - Dec 2016)**

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**Process Steps:**
- Patient Arrival
- Triage
- Room Assignment
- Resuscitation
- Waiting Room
- Physician Assessment
- Admission Decision
- Departure from ED

**Time Stats:**
- Admission Decision: 24 mins
- Bed Request: 12 mins
- Admission Approval: 23 mins
- Bed Preparation: 220 mins
- Bed Assignment: 258 mins
- Patient Transfer: 258 mins

**Units:**
- Acute Care Unit
- Fast Track
- Pediatric
- Psychiatric
- Other Treatment

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**Departments:**
- Resuscitation
- Fast Track
- Pediatric
- Psychiatric
- Other Treatment
- Admission Decision
- Patient Transfer

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**Units:**
- Acute Care Unit
- Fast Track
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**Departments:**
- Admission Decision
- Bed Request
- Admission Approval
- Bed Preparation
- Bed Assignment
- Patient Transfer
**General Wisdom**

**ED Patient IU Bed Allocation Delay (BAD)**

- Number of patients
- Hour of day
- BAD: >2Hours, >6Hours, >10Hours

**IU Rate Patterns**

- Number of patients
- Hour of day
- ED Admissions, All admissions, Discharge

**INSIGHT:** “Predict” IU admissions from ED and “timing” to facilitate proactive coordination of downstream resources/processes!

**ED is Congested with Boarded Patients for Lack of Inpatient Unit (IU) Beds!**

**Full IU Occupancy Probability**

- Boarding delays attributable to improper coordination within the ED-IU network!
- Adding staff not the solution. Need to know which IU beds to turnaround.

**Pattern** suggests that boarding delays are probably not due to full IU occupancy.
Proactive IU Bed “Reservations”: Modelling

Seung Yup Lee, Ph.D., Ratna Babu Chinnam, Ph.D., Evrim Dalkiran, Ph.D.

**Fork-Join Queueing Model Representation**

**Experiment Setting & Result:**

General IU & Imperfect Disposition Decision Predictions
Inclusion of Patients Being Admitted from Other Sources
Assumption: Unbiased disposition prediction and remaining ED LoS

>30% reduction in BAD

>50% reduction in BAD!

**INFORMS Service Science Best Paper Award – 2017**
AI Powered Predictive & Prescriptive Analytics

**ANALYTICS DEVELOPMENT:**

**Prediction Models:** Deep Learning using TensorFlow & NLP

**Explainable AI:** Gradient & Perturbation Attribution Methods

**Prescriptive Analytics:** Proactive Coordination Signals

**RESULTS:**

- **225k Patients**
- **>6M Text Notes**
- **>5M Lab/Imaging Results**
- **>90% Disposition Accuracy**

Growing information with care (structured & unstructured data) to power predictions!
Impact on ED Processes at Henry Ford Hospital

**ORIGINAL STATE:**

**PHASE #1:** Parallel bed preparation during admission approval

**PHASE #2:** Parallel bed preparation during ED treatment

*Well executed Big Data Analytics can have remarkable impacts!*