



**STRENGTHENING THE BIG DATA
& ANALYTICS ECOSYSTEM**

WAYNE STATE UNIVERSITY

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(BIG) DATA DRIVEN ANALYTICS: *Enhancing Emergency Healthcare*

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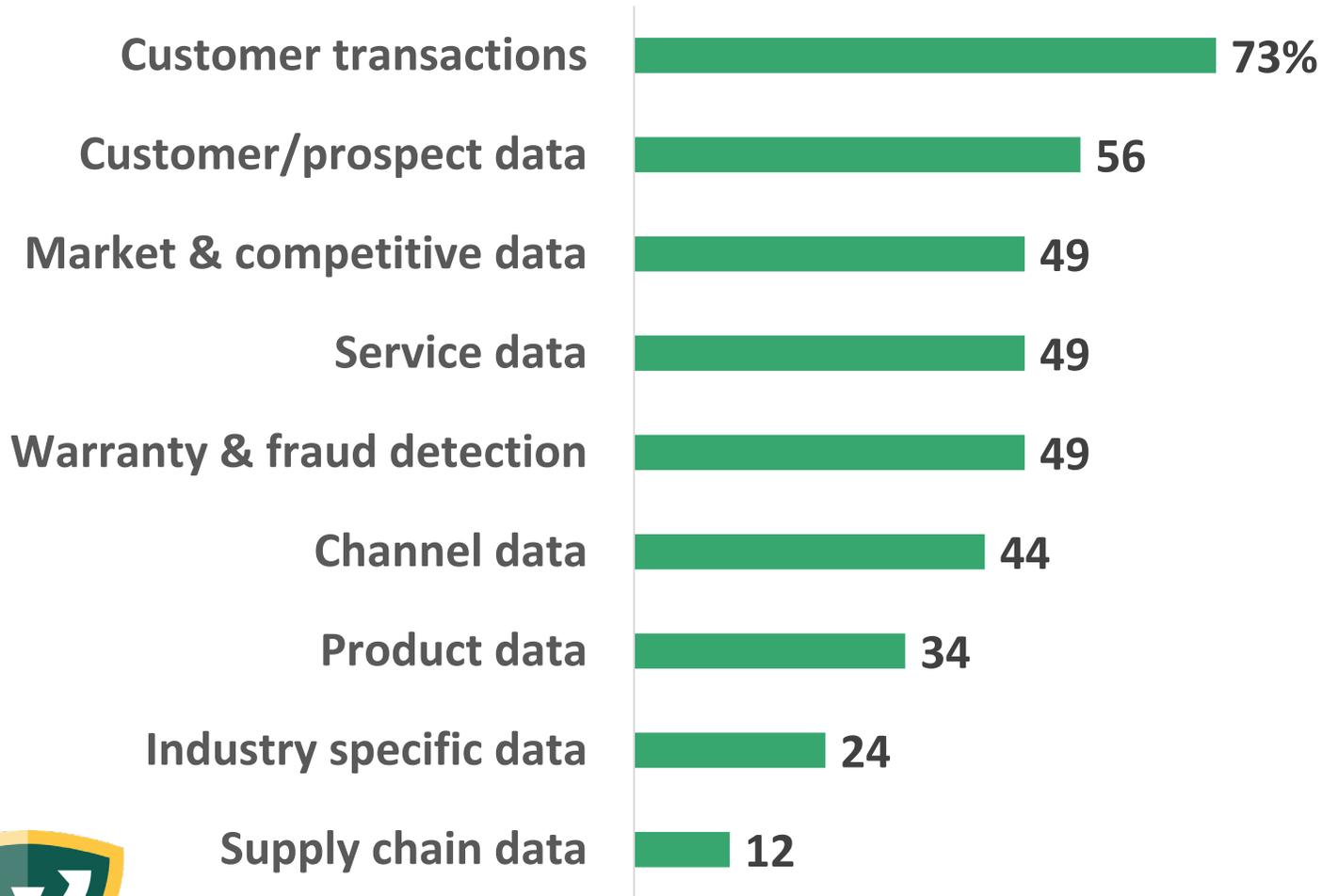
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COLLABORATORS:

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Dr. Seung Yup Lee & Dr. Evrim Dalkiran, ISE Department

Why Big Data Analytics/Technologies?

DOMAINS OF INTEREST TO PRIVATE SECTOR



MY EXPERIENCE

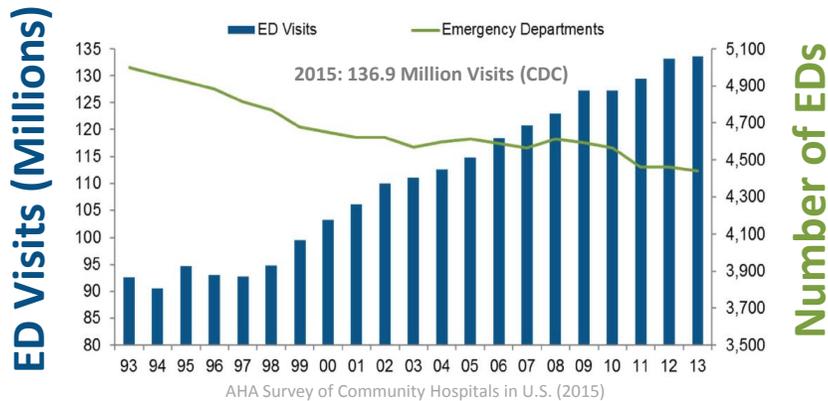


SOURCE: NEWVANTAGE PARTNERS, BIG DATA EXECUTIVE SURVEY 2012-2018 & HBR.ORG



Case Study: Enhancing Emergency Healthcare

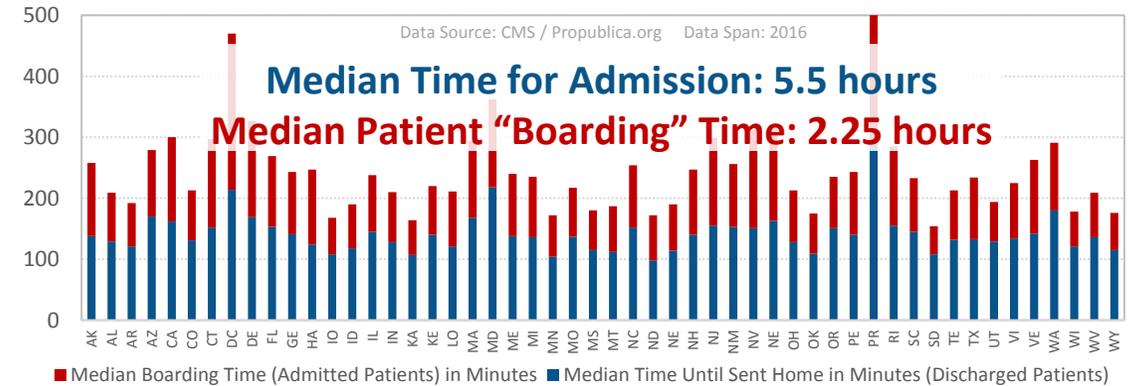
- **Current State: Ineffective service and a national crisis!**



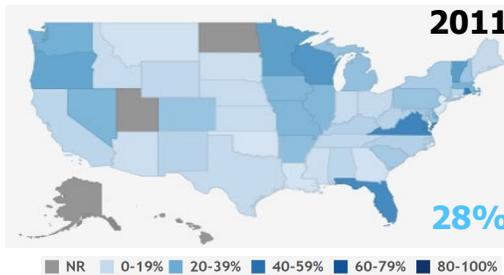
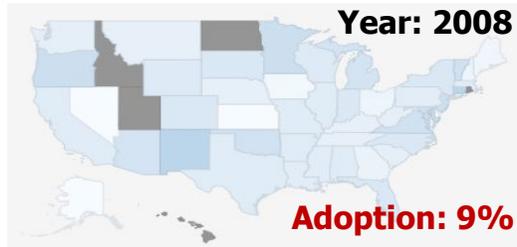
Medical Errors:
250k Deaths/Yr

76% due to
Information
Processing /
Verification

(Schnapp *et al.* 2018 | [LINK](#))



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

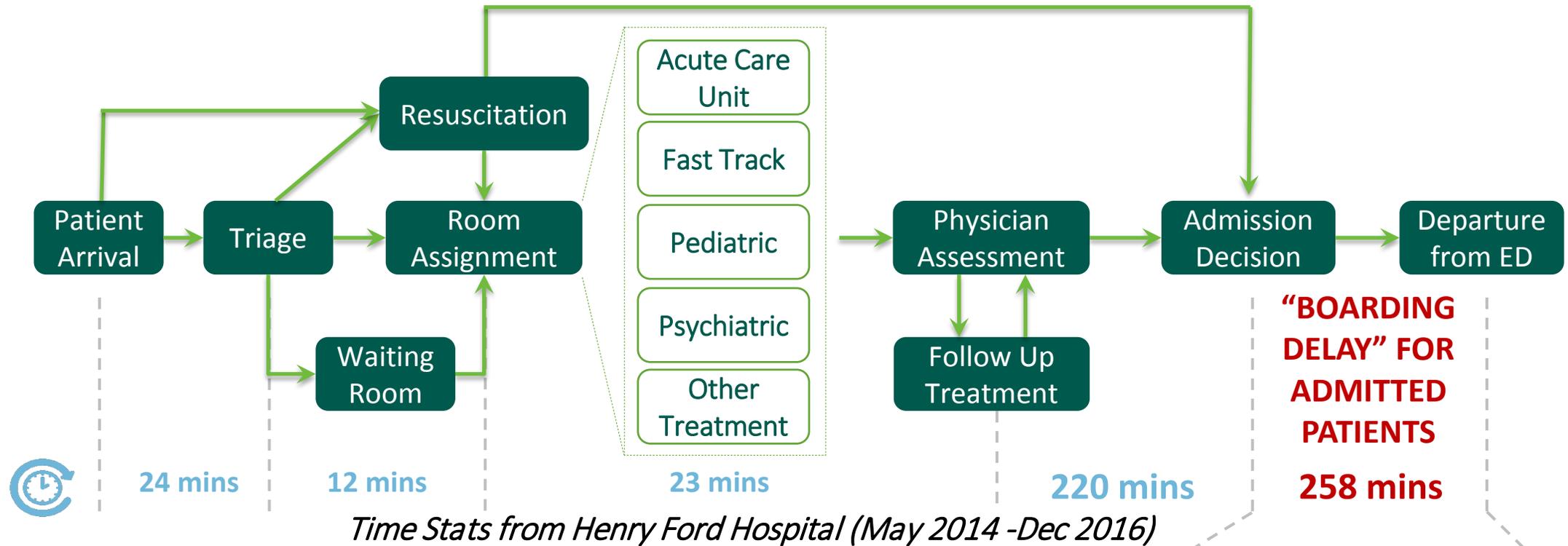


Source: Office of the National Coordination for Health Information Technology

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



Typical ED Care Giving Process



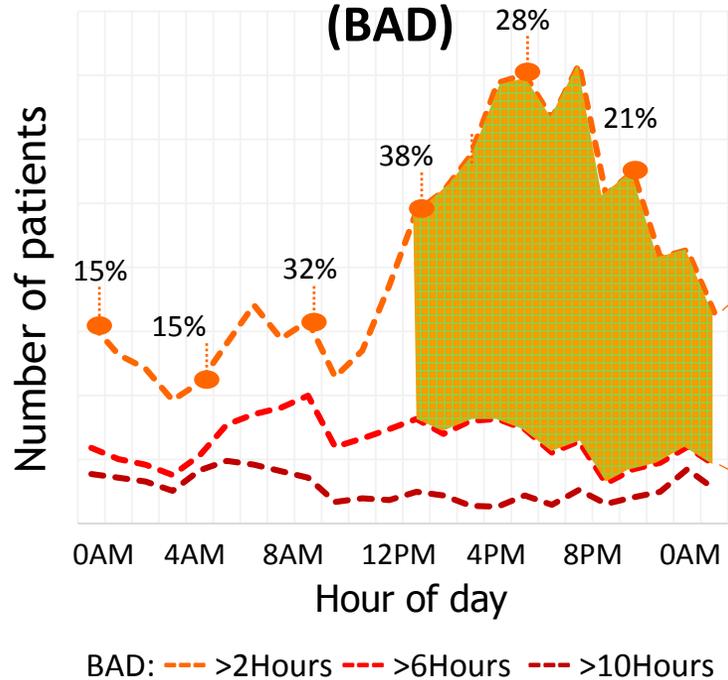
- Main driver of overcrowding
- 48% of ED length of stay
- CMS requiring boarding stats (2014)



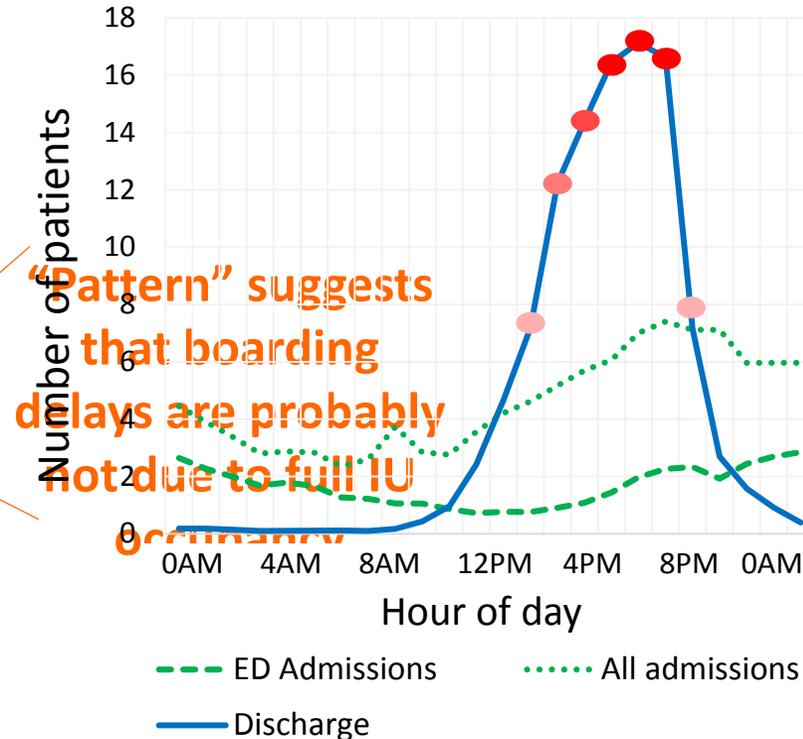
General Wisdom

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

ED Patient IU Bed Allocation Delay (BAD)



IU Rate Patterns



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.

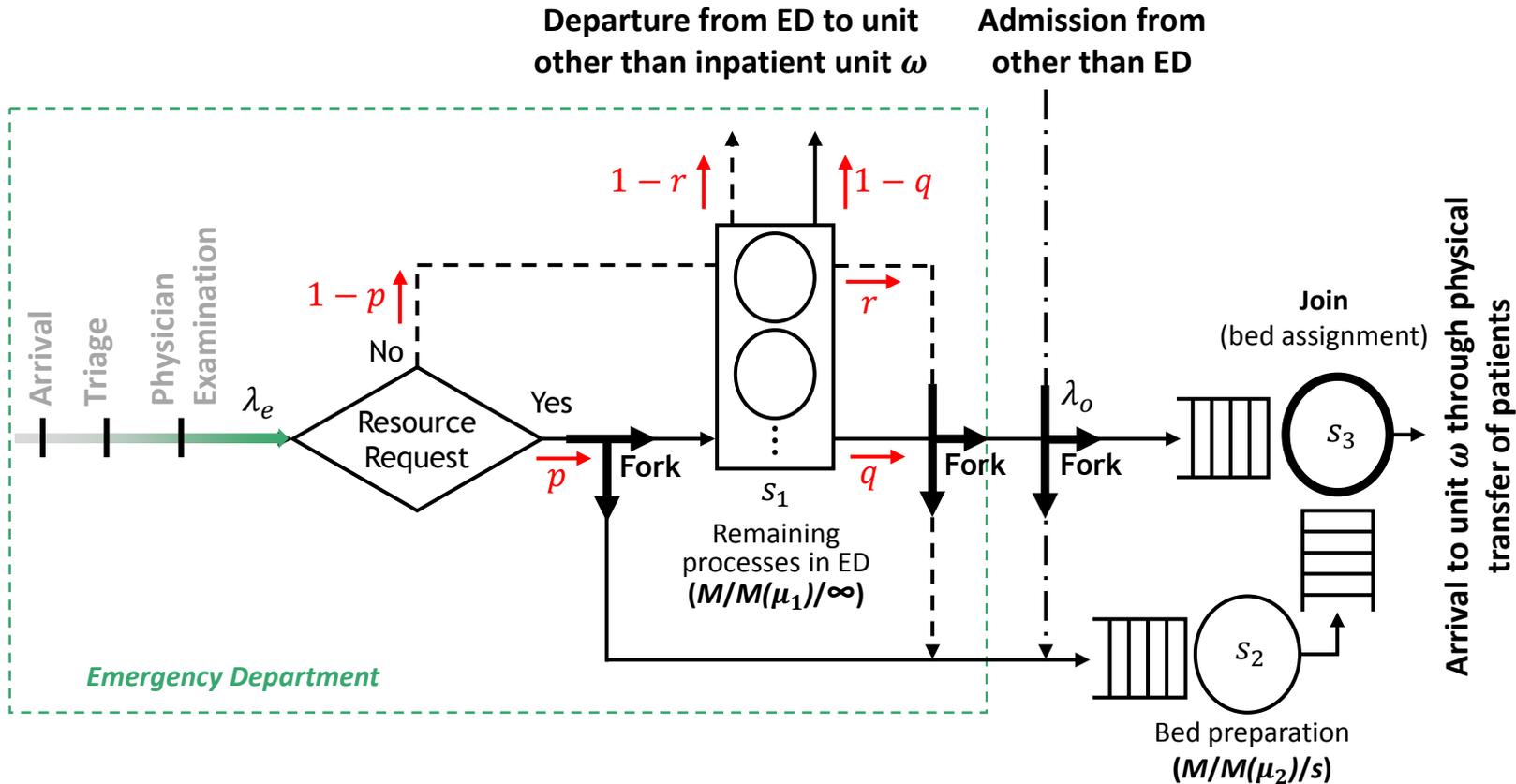
INSIGHT: "Predict" IU admissions from ED and "timing" to facilitate proactive coordination of downstream resources/processes!



Proactive IU Bed “Reservations”: Modelling

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

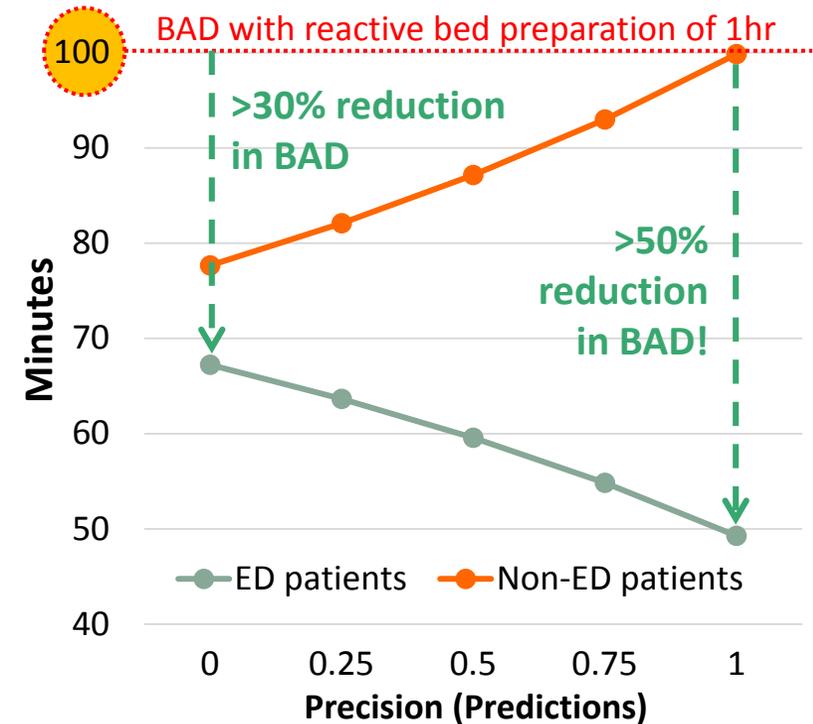
FORK-JOIN QUEUEING MODEL REPRESENTATION



NOTATION: λ : patient flow rates
 q : true positive probability (classifier)
 μ_1 : lead-time for proactive bed request signal (decision variable)
 p : probability of sending bed request
 r : false negative probability (classifier)
 μ_2 : service time at bed preparation server

EXPERIMENT SETTING & RESULT:

General IU & Imperfect Disposition Decision Predictions
 Inclusion of Patients Being Admitted from Other Sources
 Admission Rate to a Single IU: 0.2 Patients/Hour
 Each from the ED and Other Sources (50:50)
 Assumption: Unbiased disposition prediction and remaining ED LoS



**INFORMS SERVICE SCIENCE
 BEST PAPER AWARD – 2017**



AI Powered Predictive & Prescriptive Analytics



ED Process Flow



Electronic Health Record

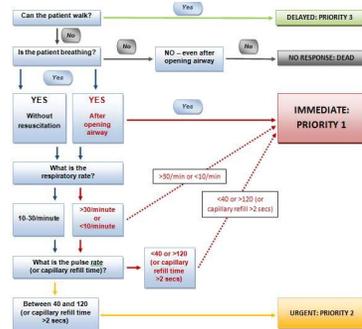
JOHNATHAN SWIFT

First Name: JOHNATHAN
Last Name: SWIFT
Age: 33
DOB: Oct 24, 1979
Gender: male
Blood Group: A+
Language: English
Marital Status: Married

Health History

- Conditions (6)
- Medications (1)
- Allergies (1)
- Immunizations (1)
- Surgical History (0)
- Family History (1)
- Social History (4)

Insurance: Anthem PPO, Deductible: \$3,500, Coinsurance: 0%, Office Visit: You pay nothing after deductible.



PROVIDER NOTES

CHIEF COMPLAINT: ****

HPI: Mr. S is a 74 year old caucasian male with a past medical and psychiatric history significant for **

PSYCHIATRIC REVIEW OF SYSTEMS
 Depression: [PSYC DEPRESS MAJOR] Denies any history of hypomanic or manic episodes.
 Psychosis: [PSYC PSYCHOSIS SCREEN RDS 8684] Denies any hallucinations or delus GAD: [PSYC GAD 8685] Denies any symptoms of GAD.
 Panic: [PSYC PANIC ATTACKS 8682] Denies any symptoms of panic.
 OCD: [PSYC OCD OBSESSIONS 8678] Denies any symptoms of OCD.
 PTSD: [PSYC PTSD 8681] Denies any PTSD symptoms.

PAST PSYCHIATRIC HISTORY
 Past Present Diagnoses: ***
 History of Outpatient Treatment: ***
 Past Medication Trials: ***
 Inpatient Psychiatric Hospitalizations: ***
 Past Suicide Attempts: ***

Lab Orders
 Vendor Order 1703R7E3 added on 02/02/17, Received
 LabCorp 69876987
 - 005009 - CBC With Differential/Platelet

Imaging Orders
 Imaging Order 1703R7E4 added on 02/02/17, Submitted
 Practice Fusion Imaging Center 3165464
 - 1115 - Chest X-Ray, 2 views PA and Lateral

Home > Laboratory			
Diagnosis	Allergies	Symptoms	Measurements
RBC (x10 ⁹ /L)	Neutrophils (x10 ⁹ /L)	Eosinophils (x10 ⁹ /L)	
20.7 kg/m ²	18.1 kg/m ²	20.7 kg/m ²	18.1 kg/m ²
15-20 kg/m ²	↑ +2.1 kg/m ²	15-20 kg/m ²	↓ -12.1 kg/m ²
		15-20 kg/m ²	↑ +2.1 kg/m ²

Growing information with care (structured & unstructured data) to power predictions!

ANALYTICS DEVELOPMENT:

Prediction Models: Deep Learning using TensorFlow & NLP

Explainable AI: Gradient & Perturbation Attribution Methods

Prescriptive Analytics: Proactive Coordination Signals

RESULTS: 225k Patients

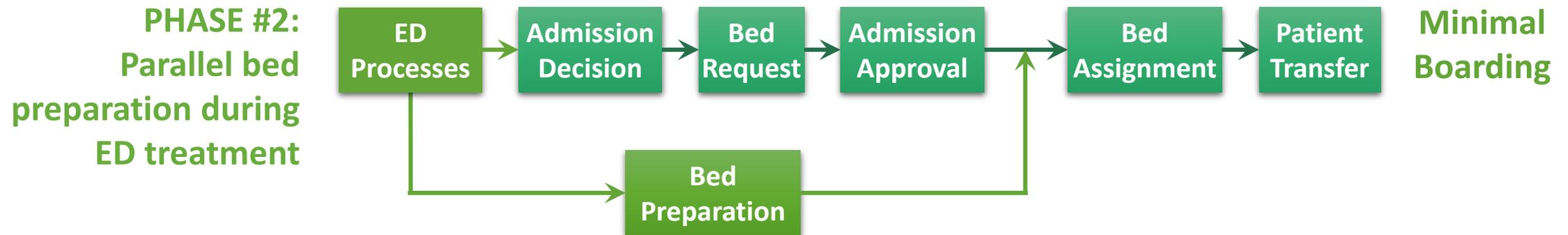
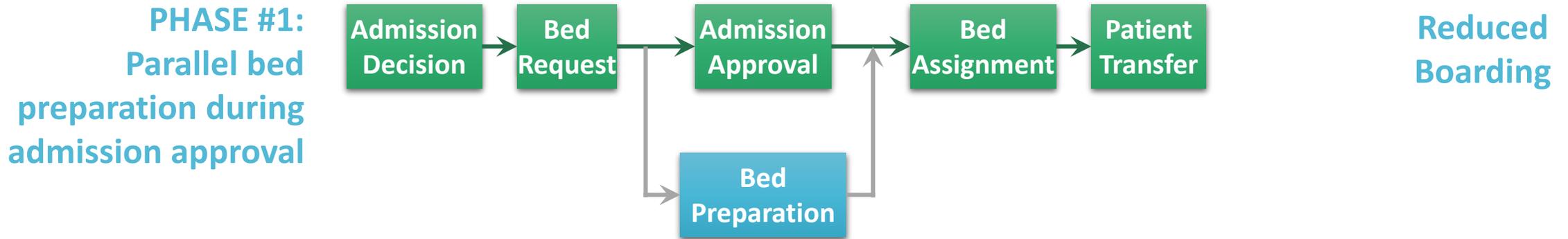
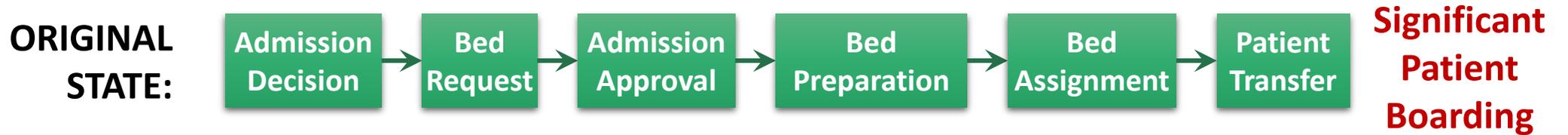
>6M Text Notes

>5M Lab/Imaging Results

>90% Disposition Accuracy



Impact on ED Processes at Henry Ford Hospital



Well executed Big Data Analytics can have remarkable impacts!

