WAYNE STATE UNIVERSITY

STRENGTHENING THE BIG DATA & ANALYTICS ECOSYSTEM
WAYNE STATE UNIVERSITY

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(BIG) DATA DRIVEN ANALYTICS:
Enhancing Emergency Healthcare

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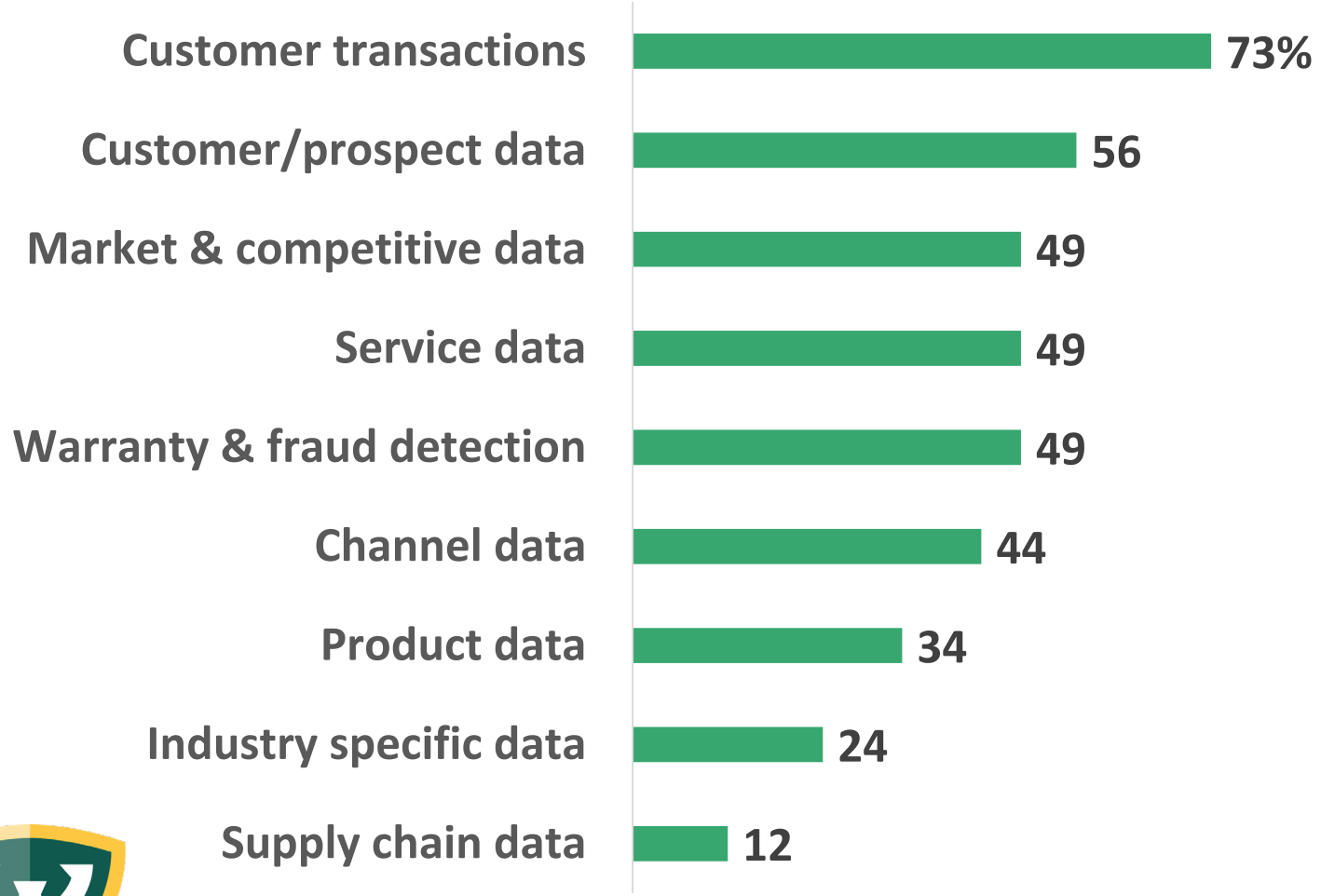
Dr. Seung Yup Lee & Dr. Evrim Dalkiran, ISE Department

Why Big Data Analytics/Technologies?

DOMAINS OF INTEREST TO PRIVATE SECTOR



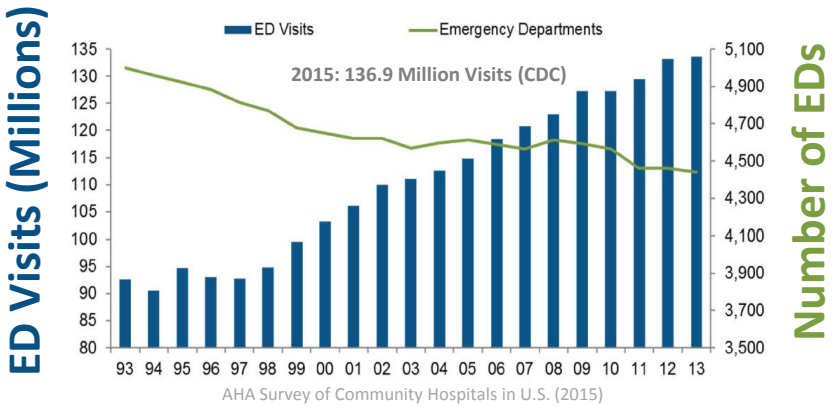
SOURCE: NEWVANTAGE PARTNERS, BIG DATA EXECUTIVE SURVEY 2012-2018 & HBR.ORG

MY EXPERIENCE

Ford
U.S. Department of Veterans Affairs
pch.com PUBLISHERS CLEARING HOUSE
SiriusXM
URBAN SCIENCE
DELPHI
Henry Ford Health System
LOVEN SYSTEMS
MAGNA
GENERAL DYNAMICS Land Systems
faurecia
traffic.com
TARDEC
Ford
GM
dFOUNDRY
MRF
Ford
DELPHI

Case Study: Enhancing Emergency Healthcare

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

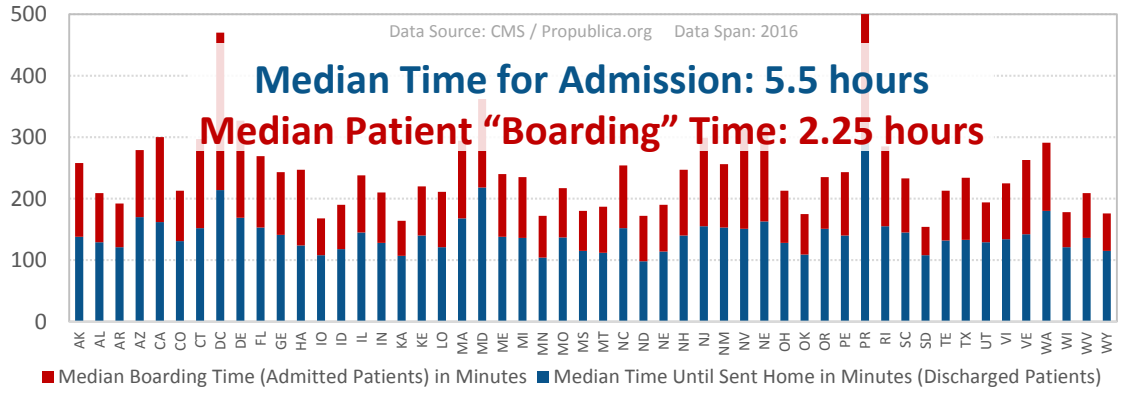


AHA Survey of Community Hospitals in U.S. (2015)

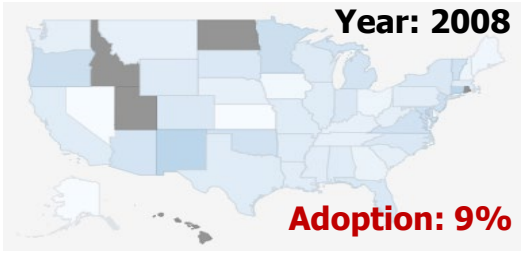
Medical Errors:
250k Deaths/Yr

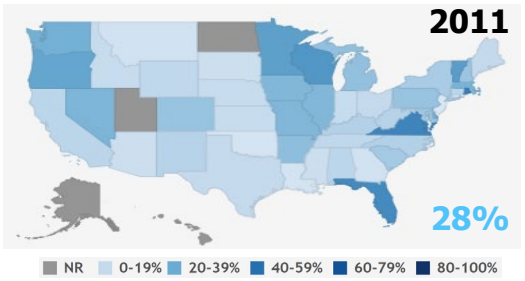
76% due to Information Processing / Verification

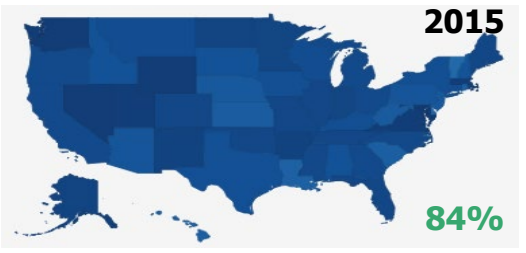
(Schnapp *et al.* 2018 | LINK)



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



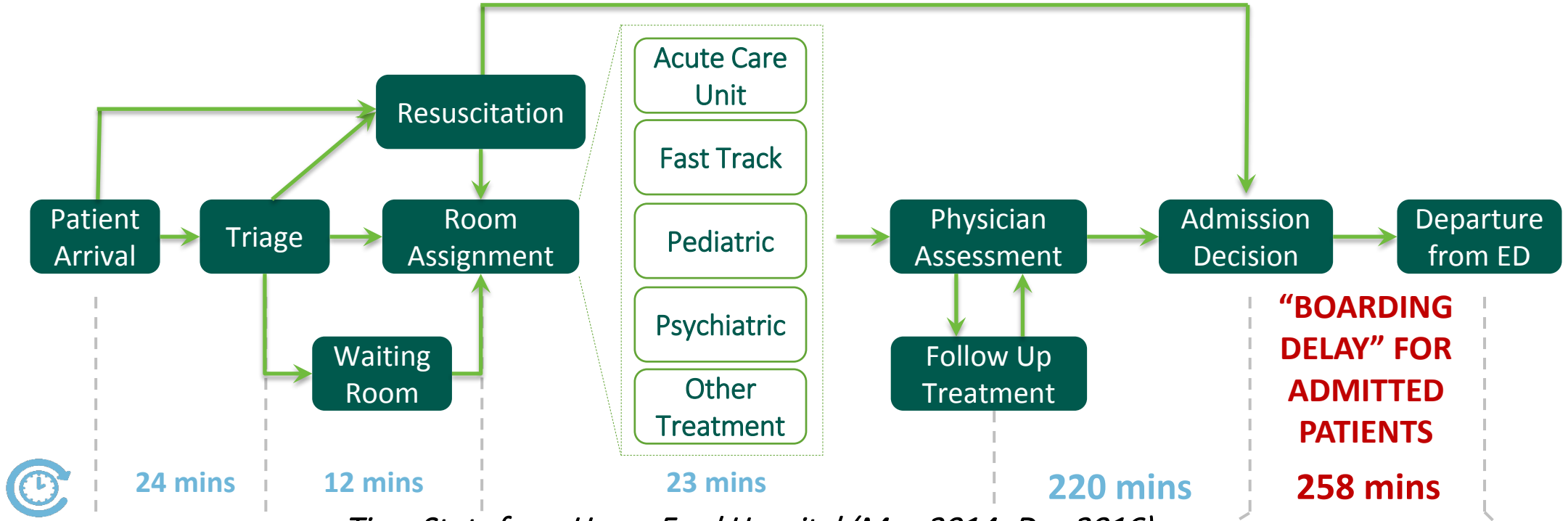




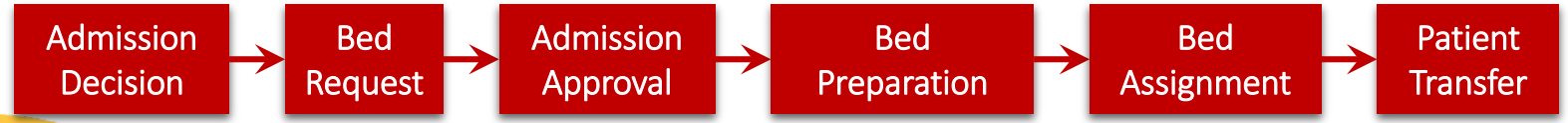
Source: Office of the National Coordination for Health Information Technology

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

Typical ED Care Giving Process



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

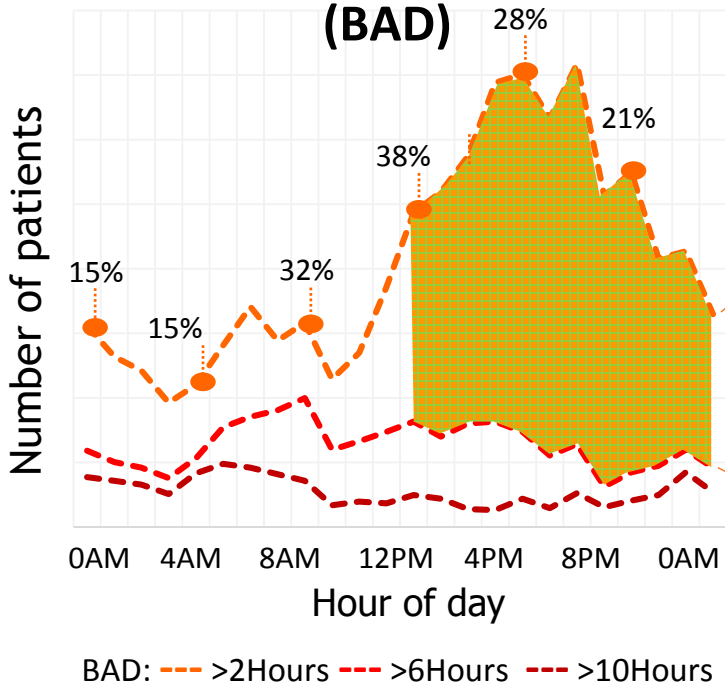


- Main driver of overcrowding
- 48% of ED length of stay
- CMS requiring boarding stats (2014)

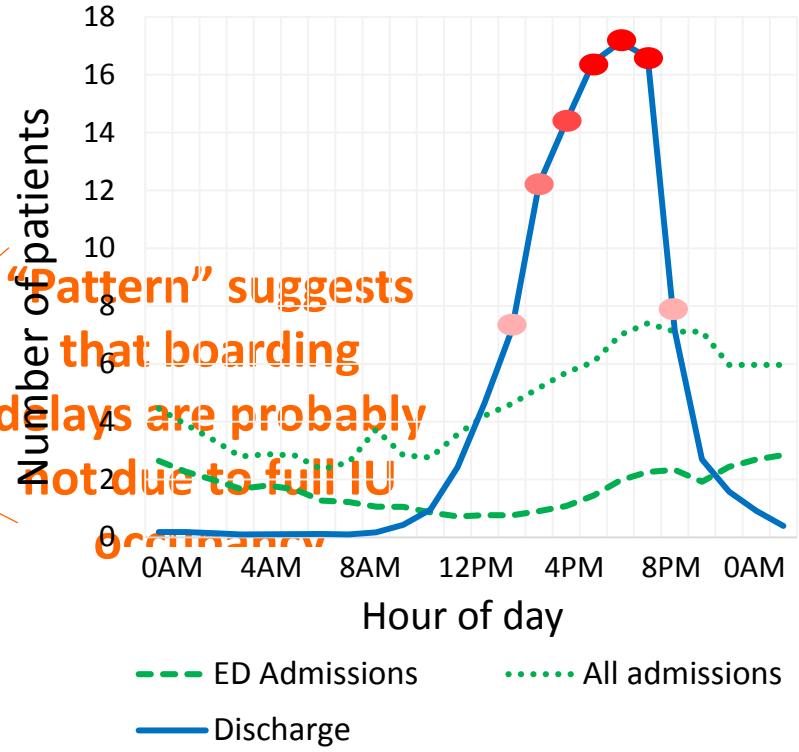
General Wisdom

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

ED Patient IU Bed Allocation Delay (BAD)



IU Rate Patterns



"Pattern" suggests that boarding delays are probably not due to full IU occupancy

Boarding delays attributable to improper coordination within the ED-IU network!

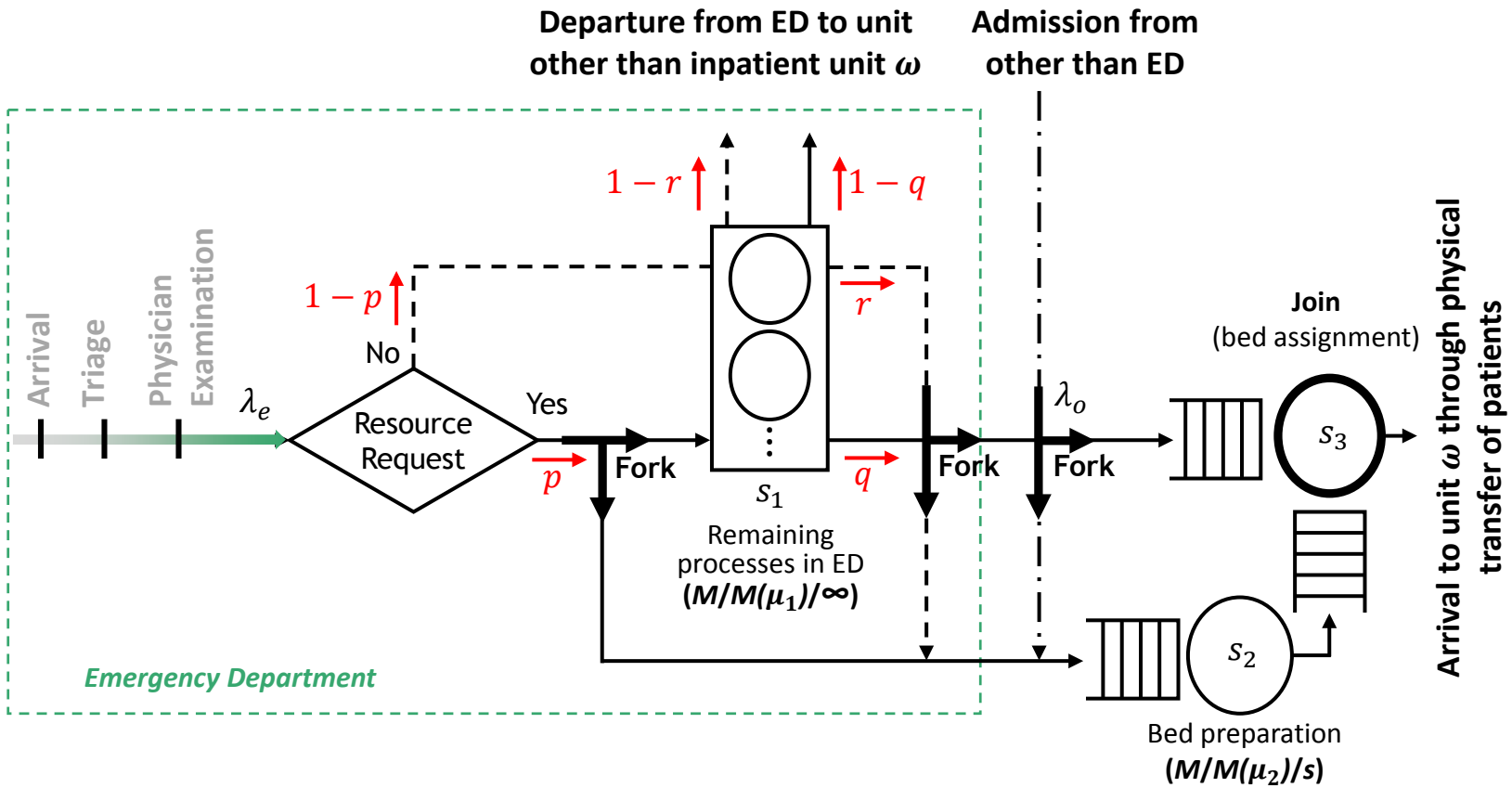
Adding staff not the solution. Need to know which IU beds to turnaround.

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

Proactive IU Bed "Reservations": Modelling

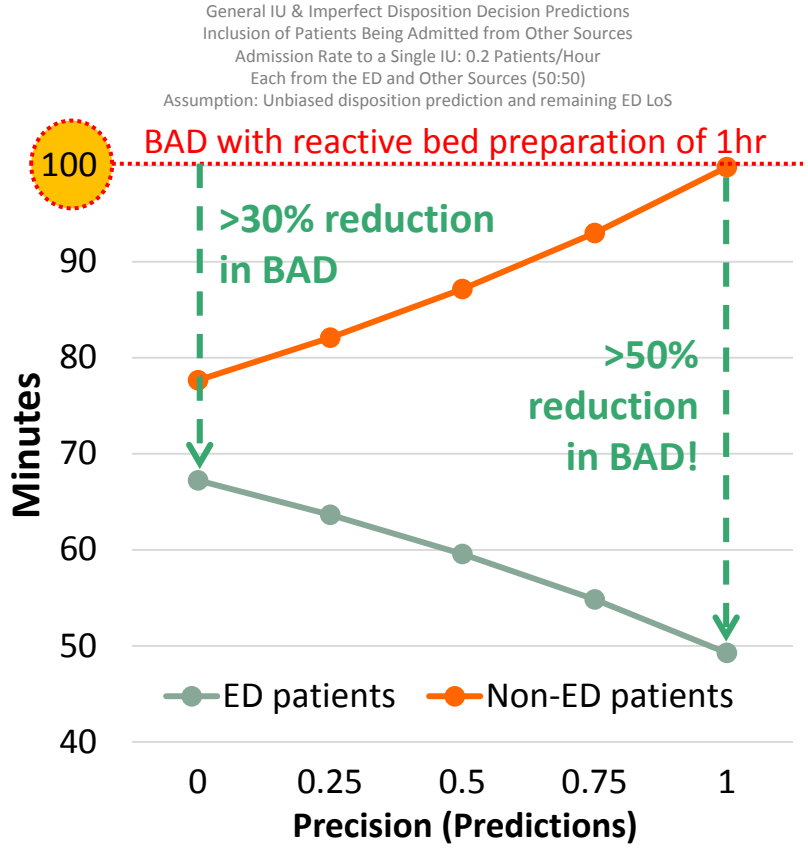
Seung Yup Lee, Ph.D., Ratna Babu Chinnam, Ph.D., Evrim Dalkiran, Ph.D.

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:



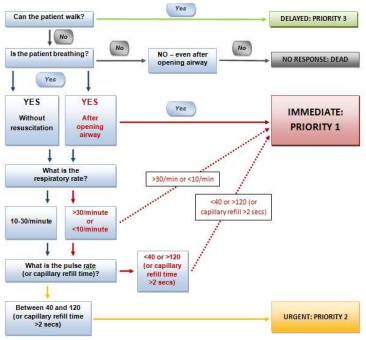
INFORMS SERVICE SCIENCE BEST PAPER AWARD – 2017

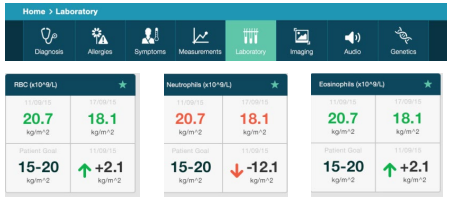
AI Powered Predictive & Prescriptive Analytics

Patient Arrival → **Triage** → **Encounter with Doctor** → **Lab / Imaging Results**

ED Process Flow

Electronic Health Record





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

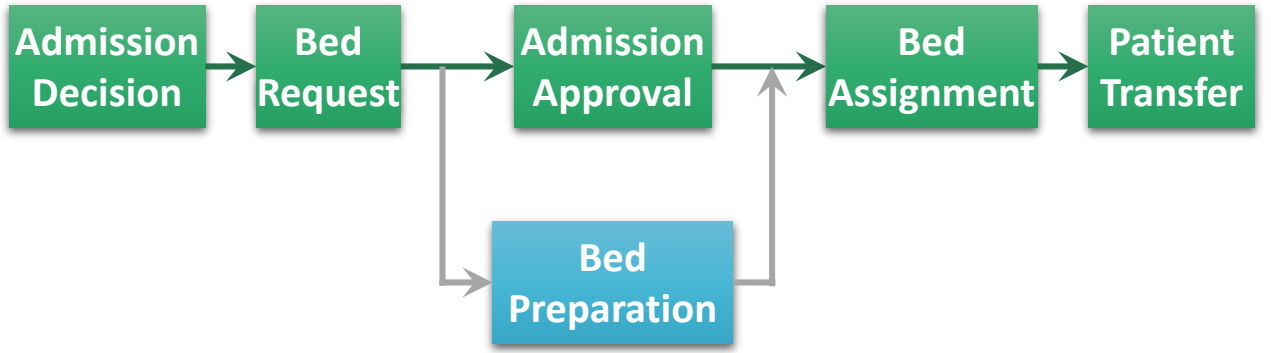
>90% Disposition Accuracy

Impact on ED Processes at Henry Ford Hospital

ORIGINAL STATE:

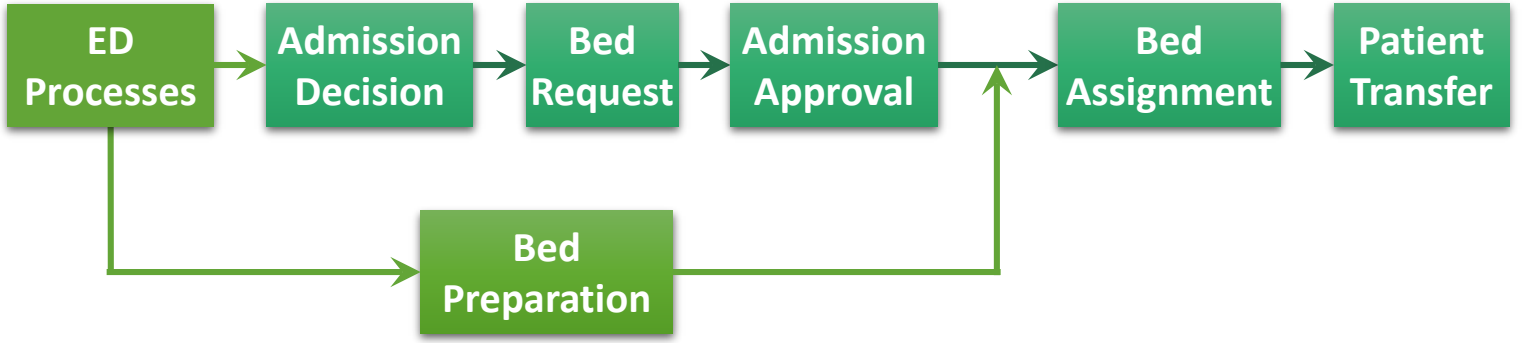
Significant Patient Boarding

PHASE #1: Parallel bed preparation during admission approval



Reduced Boarding

PHASE #2: Parallel bed preparation during ED treatment



Minimal Boarding

Well executed Big Data Analytics can have remarkable impacts!