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Artificial Intelligence For Healthcare

Patient Flow Command Center

How to best orchestrate the utilization of healthcare resources across the healthcare system

Sean Bozorgzad MD, Kirk Jensen MD, MBA

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Presentation Outline

1.Title

2.Speakers

3.The problem (SB)

4.The Consequences (SB)

5.The solution (KJ)

6.Command Center Overview (KJ)

7.The four prongs of the command center (past , present , future and virtual) (KJ)

8.Resource optimization (SB)

9.Role of AI (SB)

10.Methodology (SB)

11.Expected results (SB)

12.The future (KJ)

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The Problem:

Demand Capacity Mismatch in Healthcare

What does that mean?

Demand capacity mismatch means we fail to match the right resources to the right patients at the right time.

Demand capacity mismatch is more about inefficient deployment of available resources and less about lack of resources.

Consequences of Demand Capacity Mismatch :

Demand Exceeds Capacity

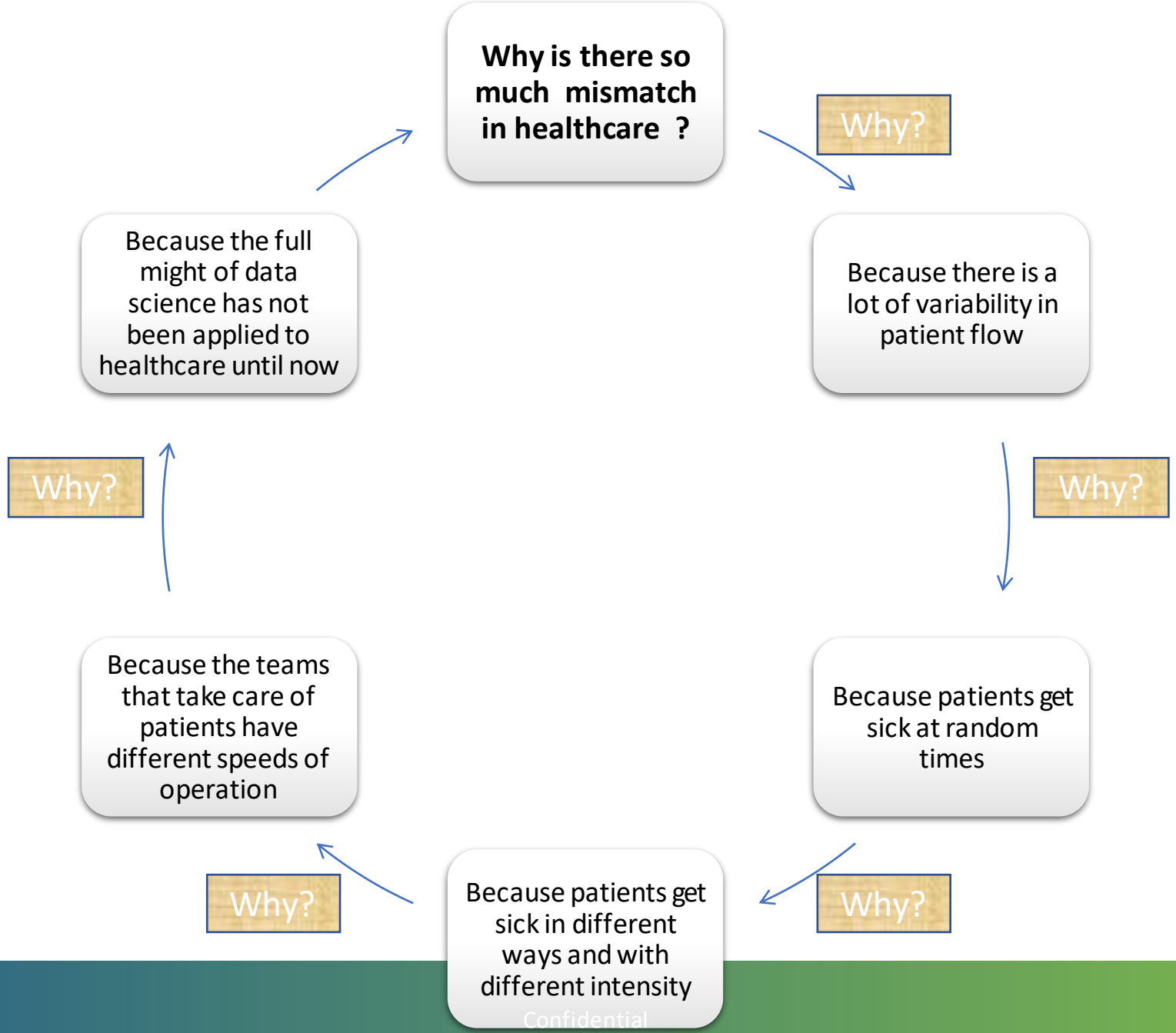
Increased Risk to Patients

Decreased Quality of Care

Capacity Exceeds Demand

Increased Waste

Higher Cost



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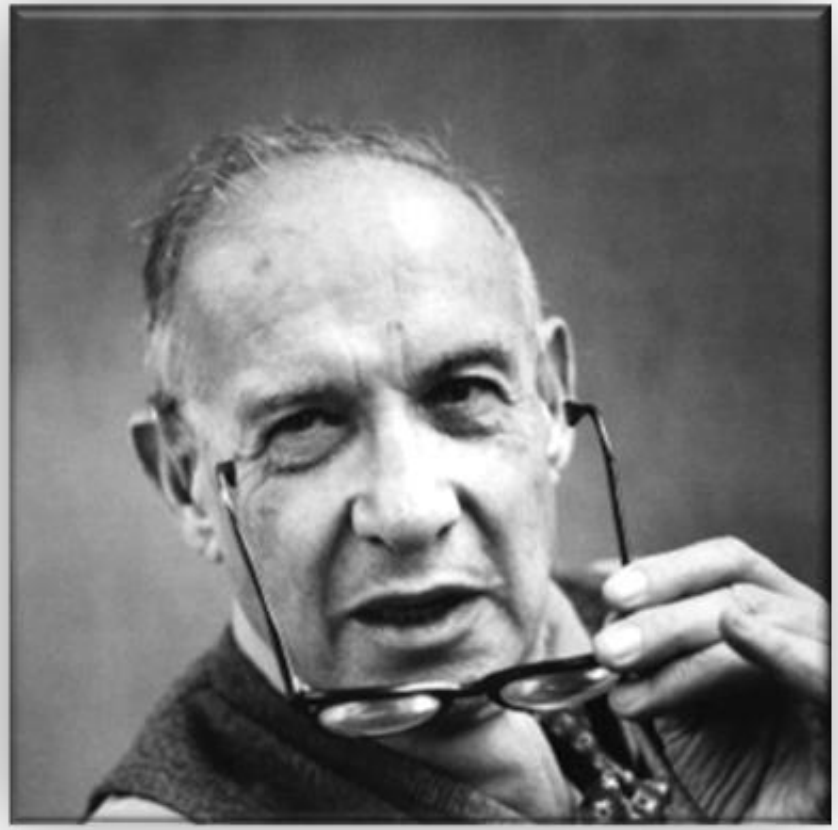
"The ***hospital*** is altogether the ***most complex*** human organization ever devised."

Peter Drucker



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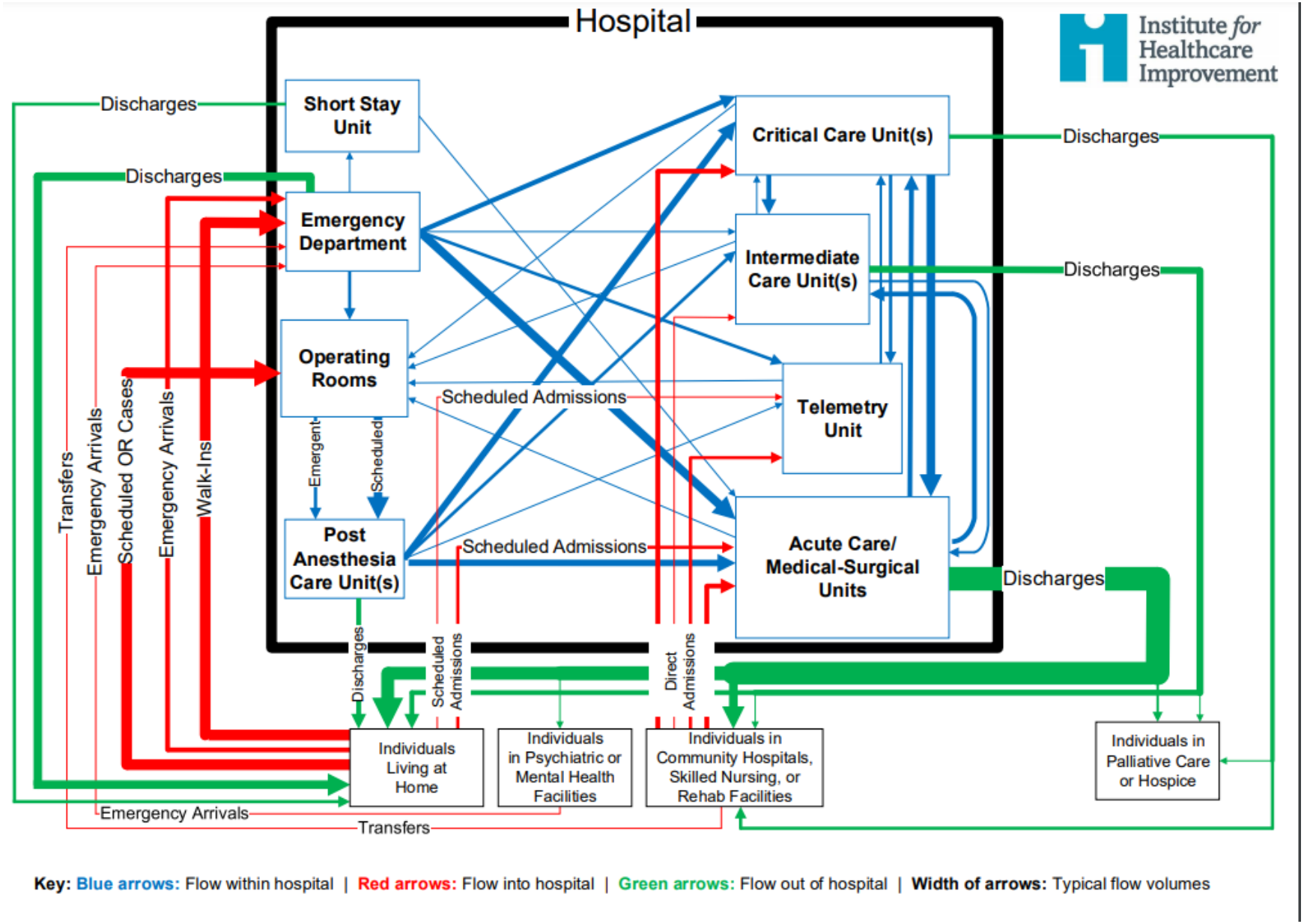
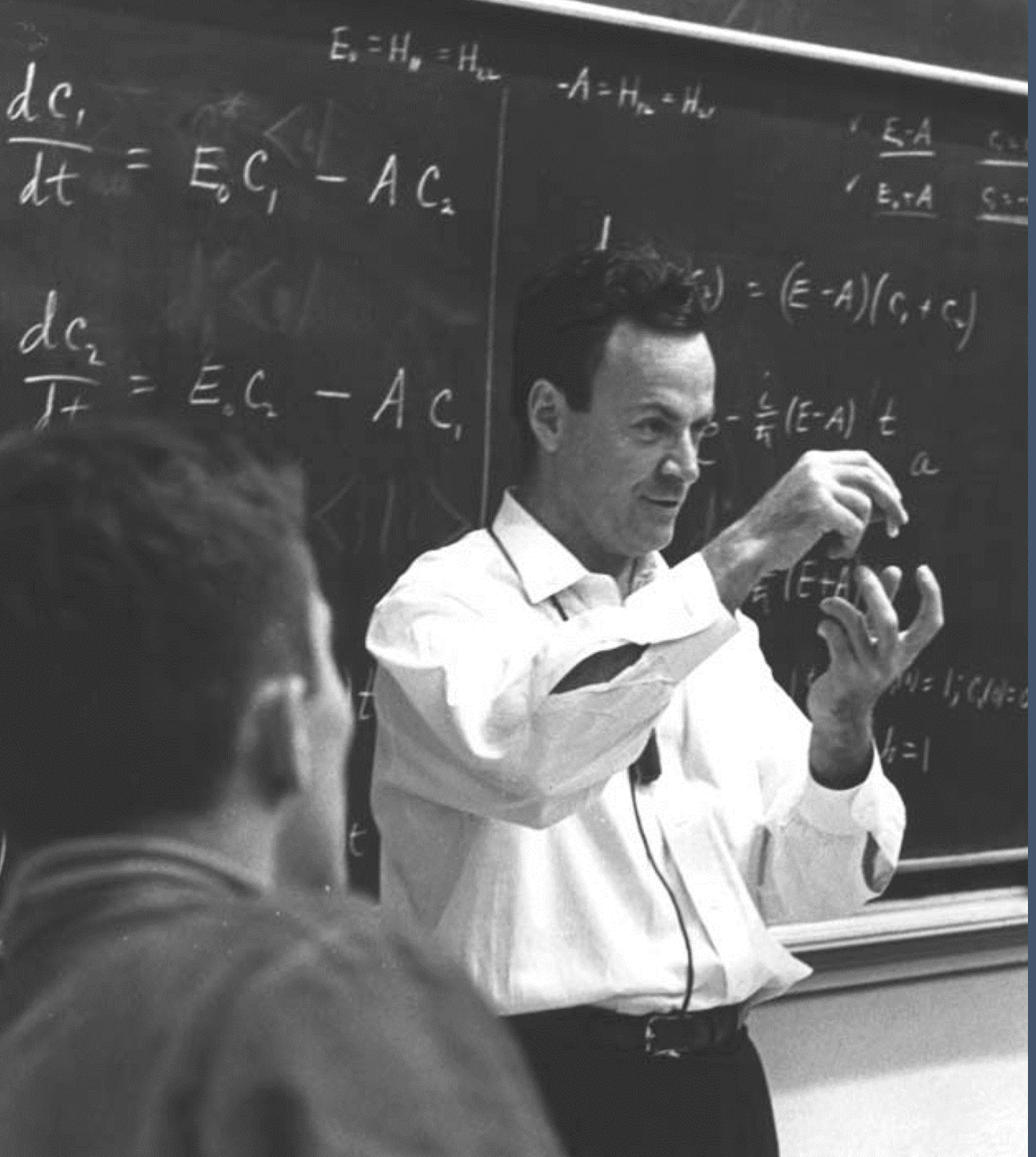
Hospital-Wide Patient Flow Is Complicated…





The Science of Clinical Operations Management as Our Route to Operational Excellence

- **Systems Thinking And Appreciation** - A system is a network of components which work together to try to achieve common aims
- **A Theory Of Knowledge -** A theory of knowledge about our system(s)- an understanding of the ED, the hospital, the healthcare system as a whole…and its processes…
- **Getting Clear About The Key Drivers Of System Performance:**
  - Demand-capacity management
  - Queuing Theory
  - The impact of Variation
- **Defining The High-Leverage Interventions:**
  - Theory of Constraints
- **Deploying A Method Or System For Improvement:** Lean, Six Sigma, TQM…
- **Where Waiting Exists -** applying ***The Psychology of Waiting Lines***

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Systems Thinking* - Selected Observations

- A system is an interdependent group of items, people, or processes working together toward a common purpose.
- Optimization of a system requires orchestrating the efforts of all components of the system toward achieving the stated purpose.
- If each part of a system, considered separately, is made to operate as efficiently as possible, the performance of the system as a whole will be suboptimized.
- Every system is perfectly designed to get the results it gets

*Rutherford PA, Anderson A, Kotagal UR, Luther K, Provost LP, Ryckman FC, Taylor J. Achieving Hospital-wide Patient Flow (Second Edition). IHI White Paper. Boston, Massachusetts: Institute for Healthcare Improvement; 2020. (Available at www.ihi.org)

Demand-Capacity Modeling & Management is of Critical Importance…

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Demand-Capacity Management Simplified…

The Key Questions:

- How many patients are coming?
- When are they coming?
- What are they going to need?
- Is our service capacity going to match patient demand?
  - **And what are we/you going to do about it if it doesn't?...**

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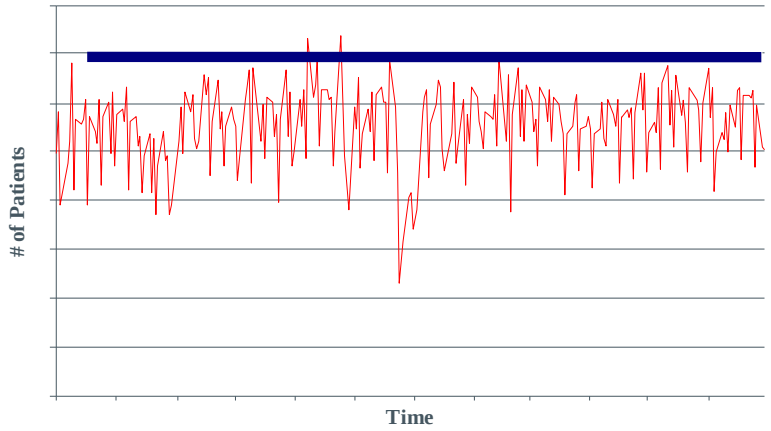
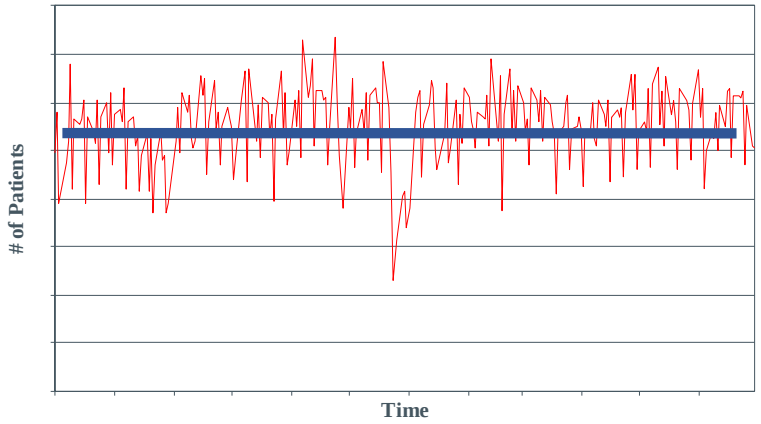
Demand/Capacity Management Challenges

What should capacity look like to guarantee quality care?



Staffing for >95% census/occupancy

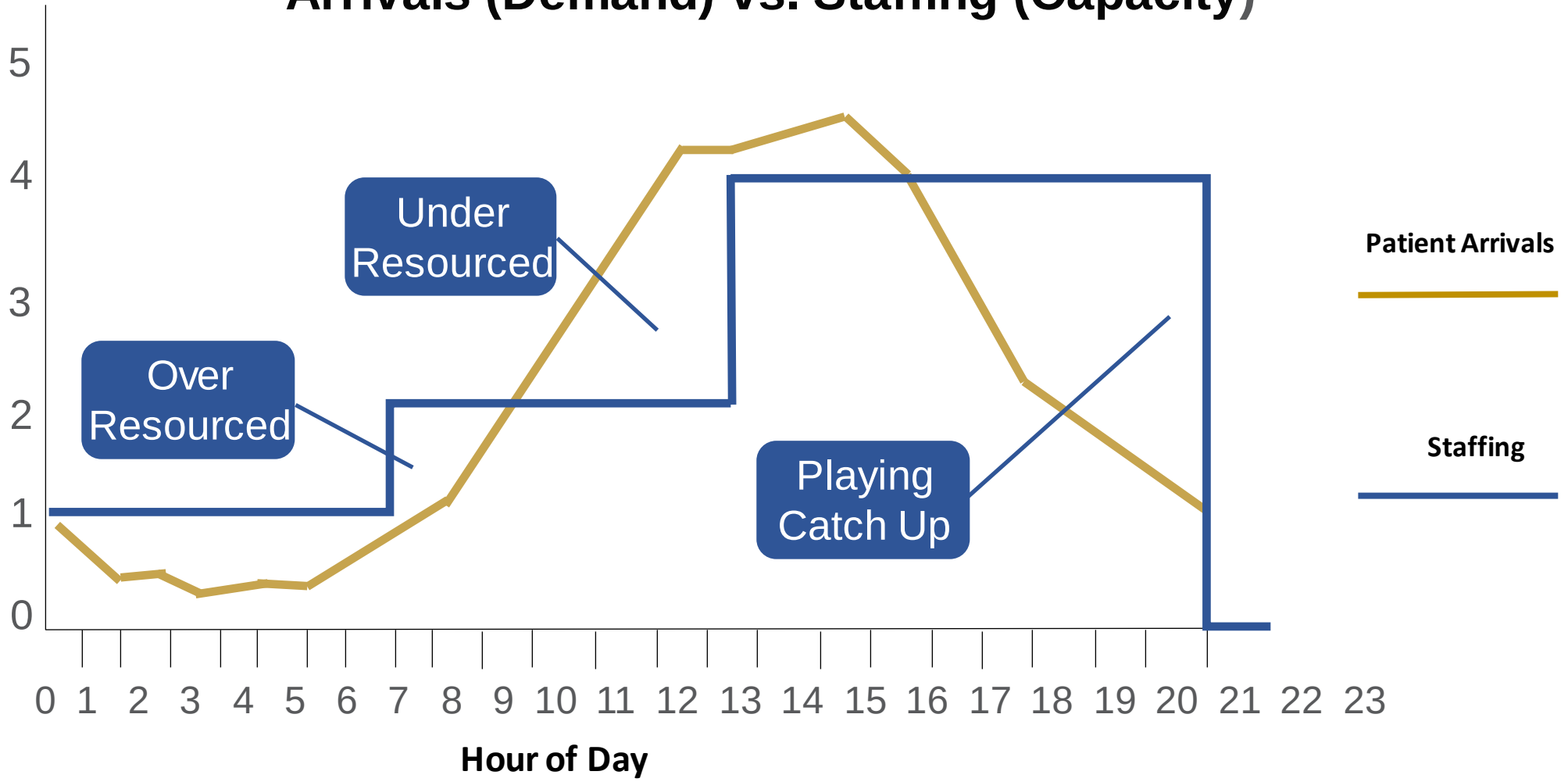


Staffing for > average census/occupancy

Eugene Litvak PhD, IHMO

Demand-Capacity Management Challenges

Arrivals (Demand) vs. Staffing (Capacity)



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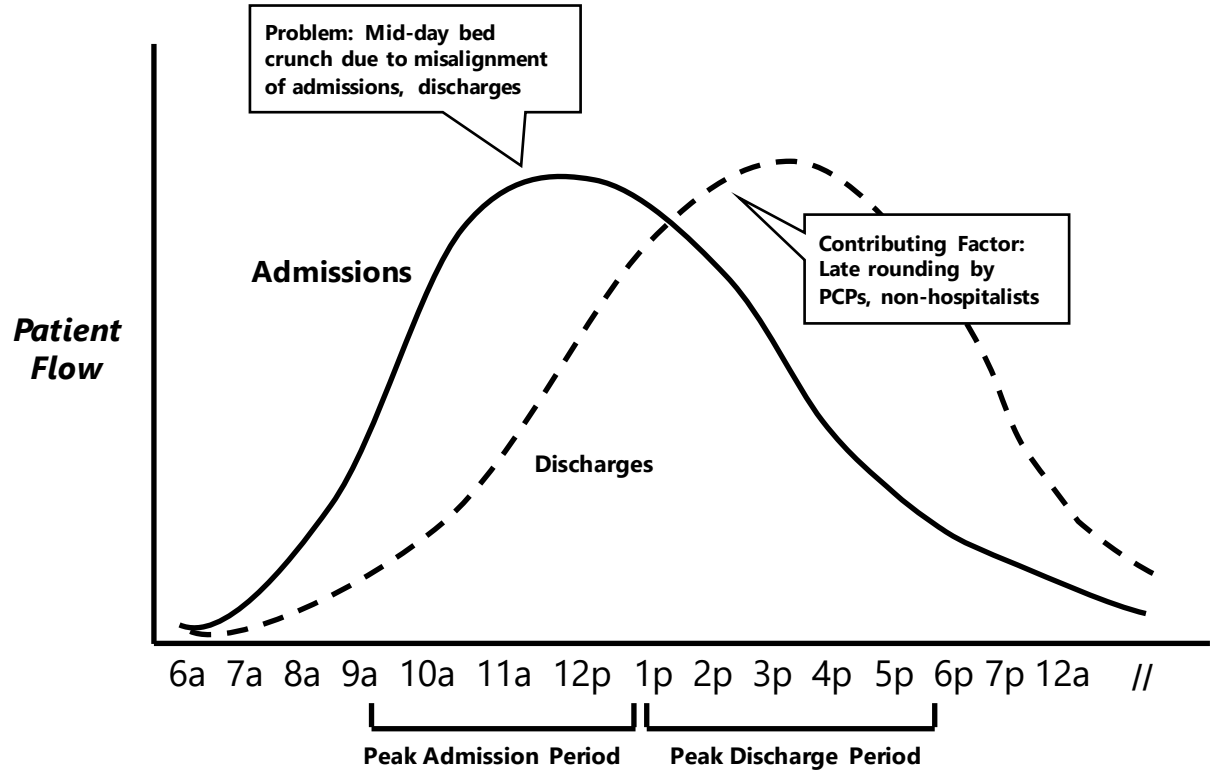
Demand-Capacity Management Challenges - Admissions and Discharges Misalignment



Courtesy of The Advisory Board Company

Why Don’t We…

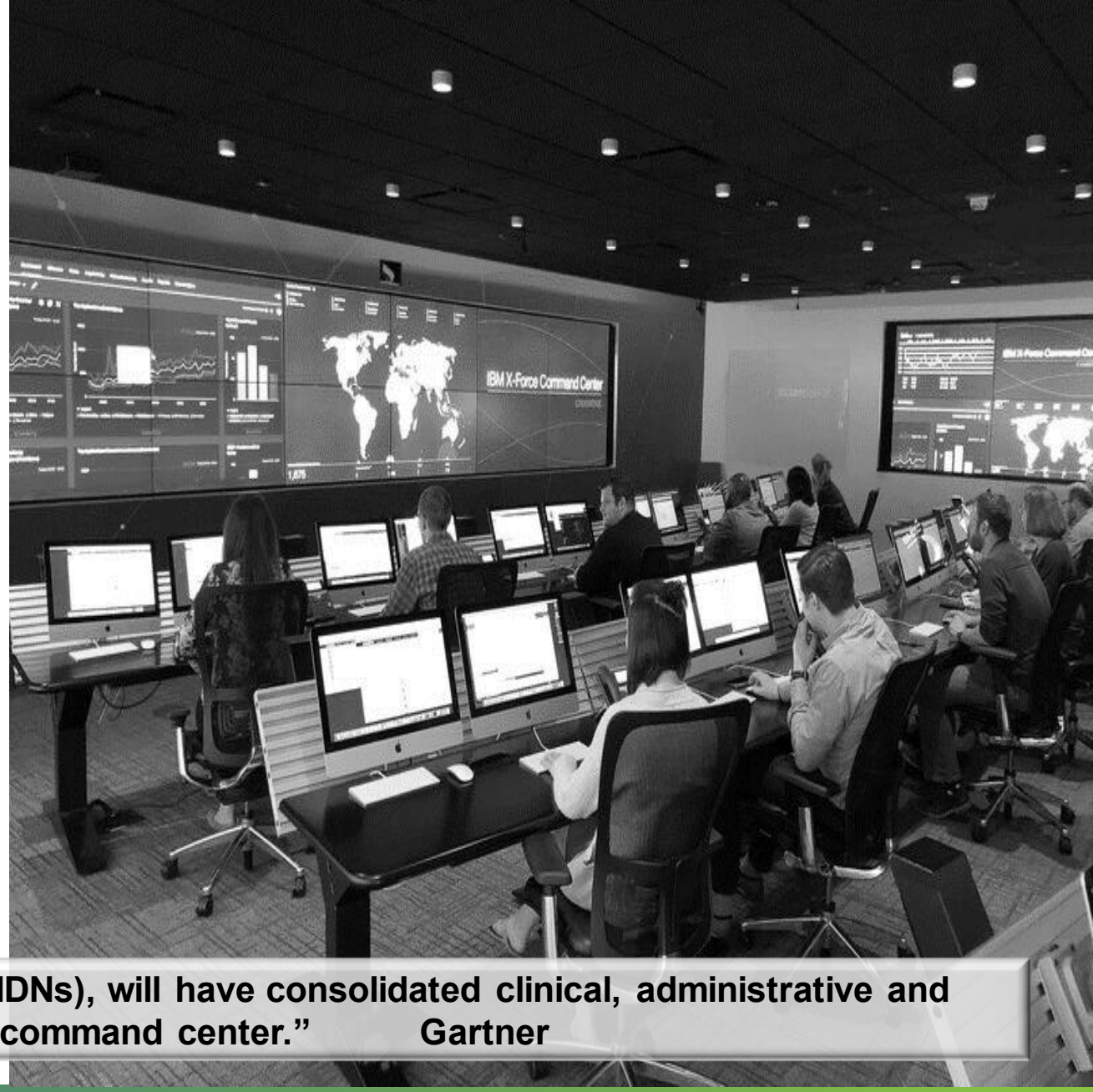
- Get **proactive** rather than **reactive**…
  - Using data analytics and AI to predict events
- Adopt an ‘**air traffic control**’ model rather than a ‘**flying by the seat of our pants**’model…
  - Coordinating transfers, discharges, transportation, staffing and support services across the entire healthcare system
- Realize that ‘some is not a number, soon is not a time, and **somehow is not a strategy’**…
  - Deploying a command center operations facility & strategy to optimize patient care capacity, flow, resources and staffing needs

Command Center Defined

A command center leverages the latest computational and data science capabilities to convert bits of data to actionable insights designed to improve the quality of human decisions which ultimately results in improvement of patient flow and quality of care.

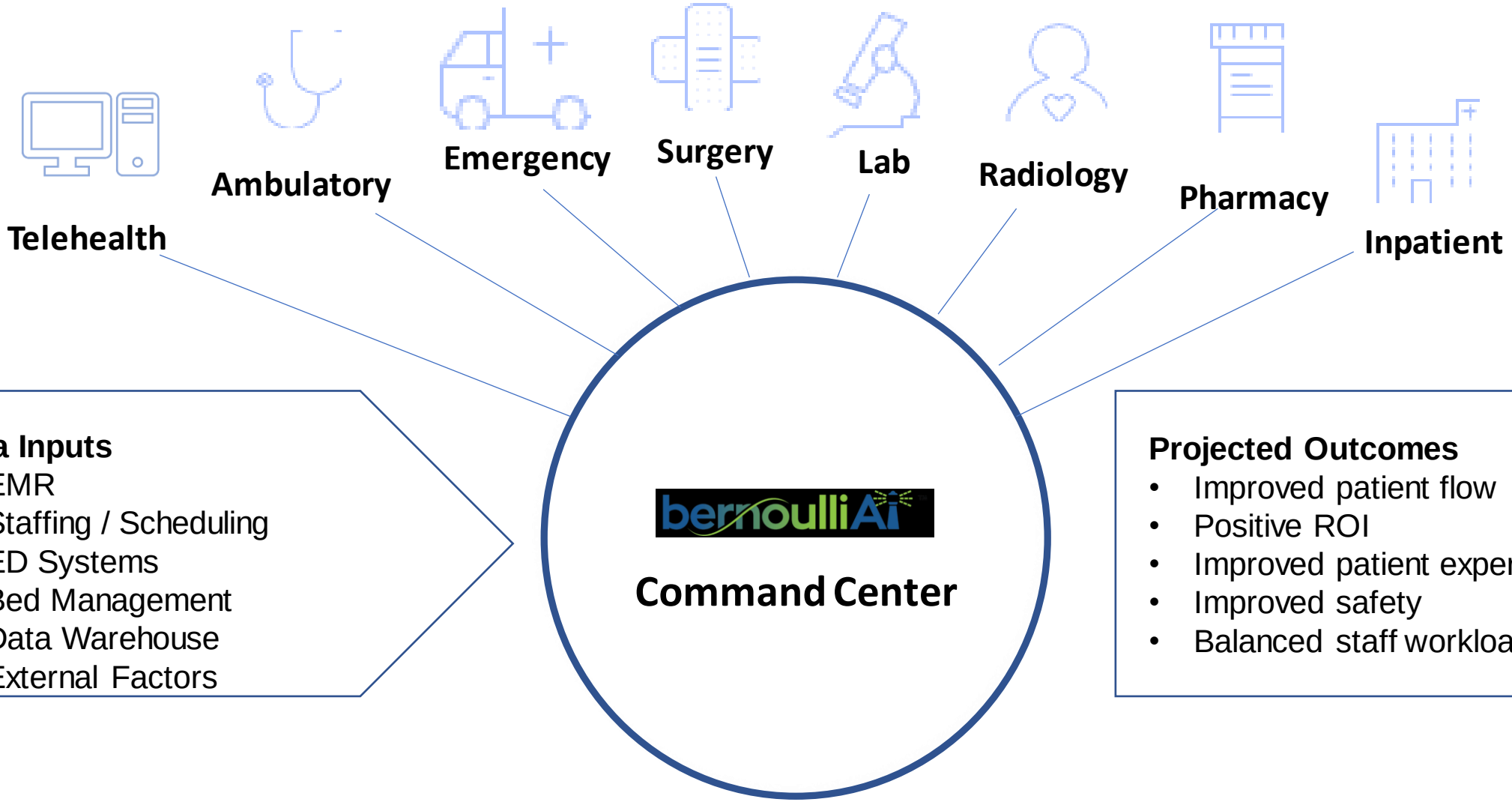
A centralized operational control centre in which AI and predictive analytics are leveraged as a part of a coordinated approach to:

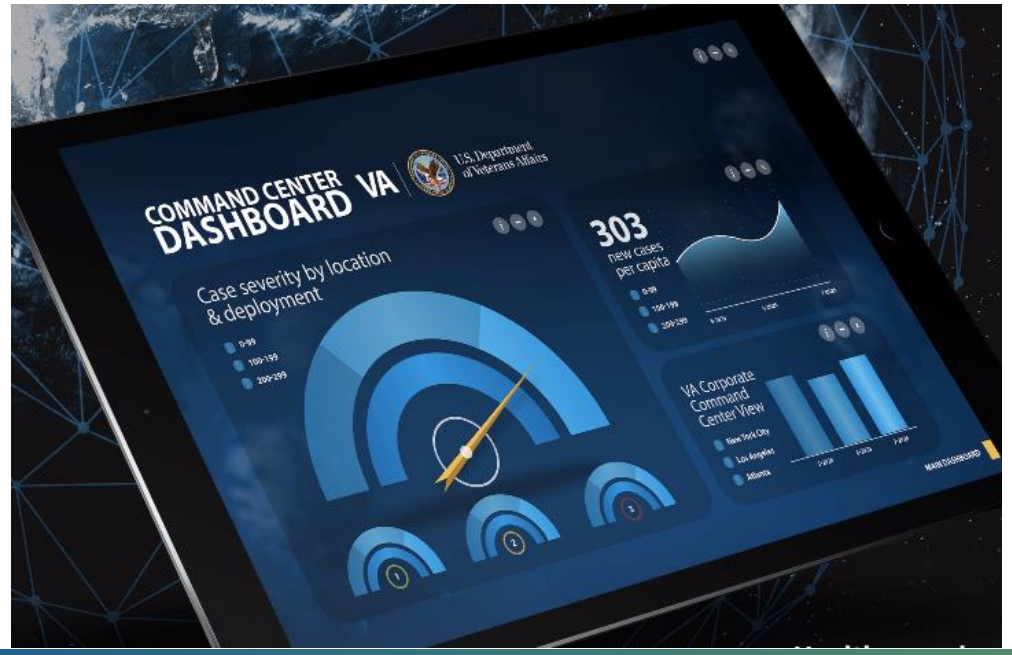
- Support optimal delivery of patient care
- Provide enterprise visibility
- Improve coordination of resources across a healthcare system



“By 2025, 50% of large integrated delivery networks (IDNs), will have consolidated clinical, administrative and operational monitoring into a command center.” Gartner

Command Center Overview – Framework





Command Center Overview – Key Components

- Enabling interventions through predictive models, alerts, notifications
- Operational Dashboards, data tracking, reporting
- Real Time monitoring and visibility of Resources
- Machine/deep learning and AI algorithms utilize information collected to predict future outcomes based on the metrics available
- Benefits tracking and continuous improvement capabilities
- Create “what if” scenarios with staffing and flow with immediate results

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Orchestrating the deployment of the **right resource** to the **right place** at the **right time**.

A Four-Pronged Approach to Patient Flow Improvement

1

Use Alarms to identify and correct **current** problems

2

Use AI and Simulation to prevent **future** problems

3

Use Historical data to **understand patterns and optimize baseline** Operations

4

Create **"What If"** scenarios from simulation

Improving the accuracy of insights while reinforcing the right decision, for the right person, at the right time

What Can A Patient Flow Command Center Do For You?

A Command Center

- Aggregates and synthesizes all of the information that is out there that you need to know in order to manage the performance of your healthcare system.
- Puts your finger on the pulse of your healthcare system by examining, in real-time, all the internal and external signals affecting your flow.
- Acts as an early warning system that can issue alerts before problems hit.
- Has a simulation engine that allows you to fast forward the current conditions and identify future bottle necks.
- Has an AI powered optimization engine that helps you search for the best deployment of resources to alleviate bottlenecks before they occur.
- Improves the quality of your decisions by giving you actionable insights.

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The biggest barrier to optimization:

Variability

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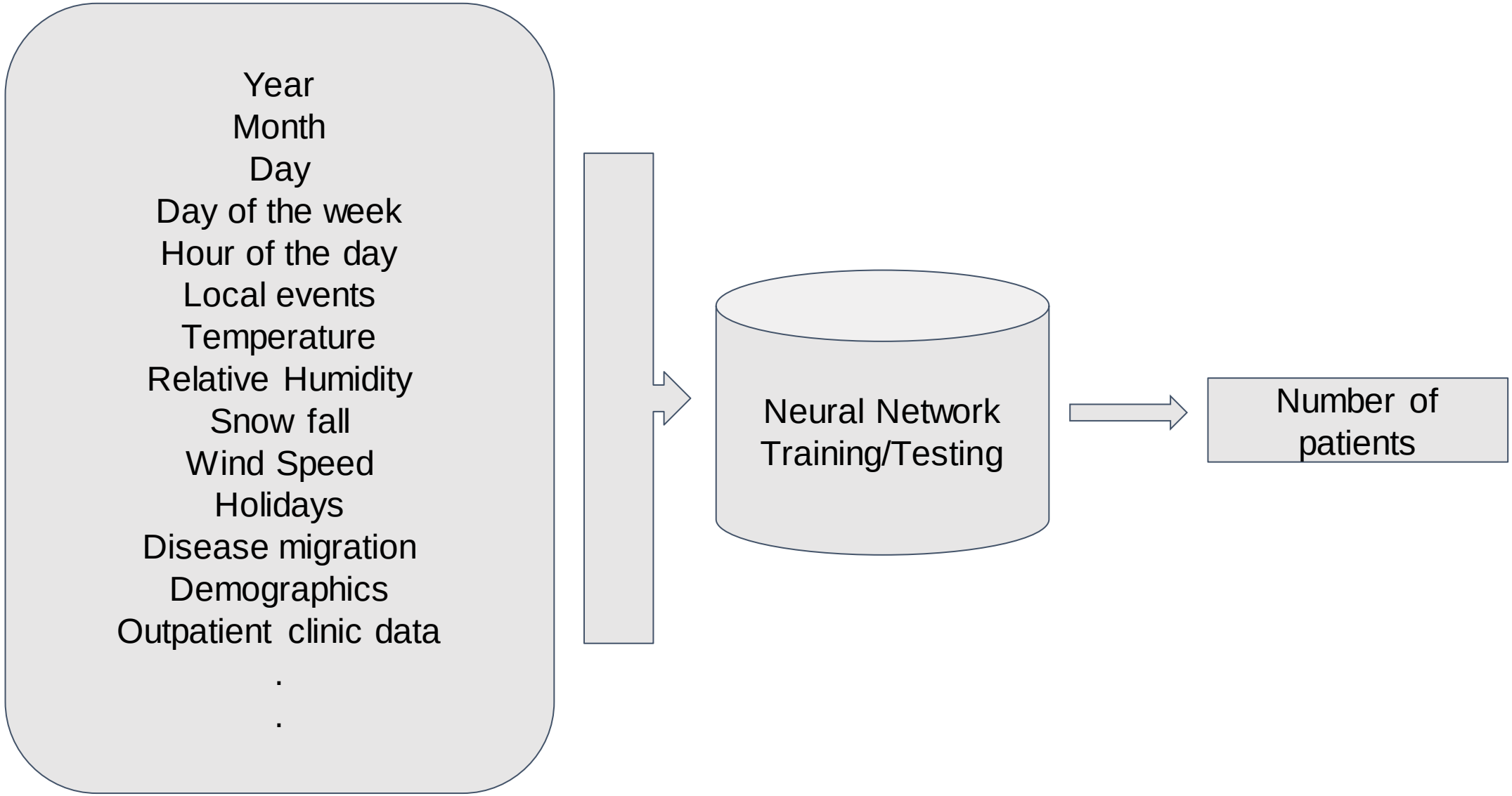
Techniques to address variability

- Improve sorting of patients
- Recognize patient flow patterns (hourly, daily, weekly, seasonally and …)
- Break down the process to its subcomponents and create a simulation engine
- Use AI and Machine learning to predict future demand
- Build a flexible system where capacity can be changed with short notice
- Build a communication platform where the insights can be shared with the healthcare team in real time

Utility of Artificial Intelligence and Machine Learning in the Command Center

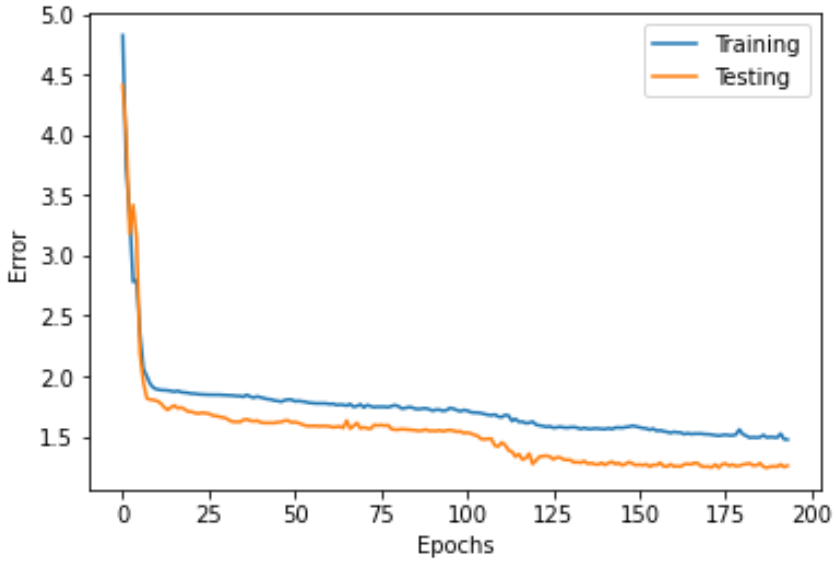
1. Machine learning algorithms are used on the historical data to predict future patient arrivals and hence predict future demand
2. Search Algorithms are used to find the absolute best combination of resources to achieve desire flow metrics
3. Deep learning Models (RNN) are used to train the models
4. Stochastical AI modeling is used to build a simulation engine which allows the operations team to analyze the response of the system to changes in demand and capacity


Year
Month
Day
Day of the week
Hour of the day
Local events
Temperature
Relative Humidity
Snow fall
Wind Speed
Holidays
Disease migration
Demographics
Outpatient clinic data
.
.
Neural Network
Training/Testing
Number of
patients

Features:
month
Day of the week
Hour of the day
BINS : 13
83.4% but now 82.9%

Layer (type)	Output Shape	Param #
lstm_231 (LSTM)	(None, 1, 128)	67584
lstm_232 (LSTM)	(None, 200)	263200
dense_458 (Dense)	(None, 50)	10050
dense_459 (Dense)	(None, 20)	1020
dense_460 (Dense)	(None, 1)	21

Total params: 341,875
Trainable params: 341,875
Non-trainable params: 0



Training set: 2019
Procedure: Test on 2020

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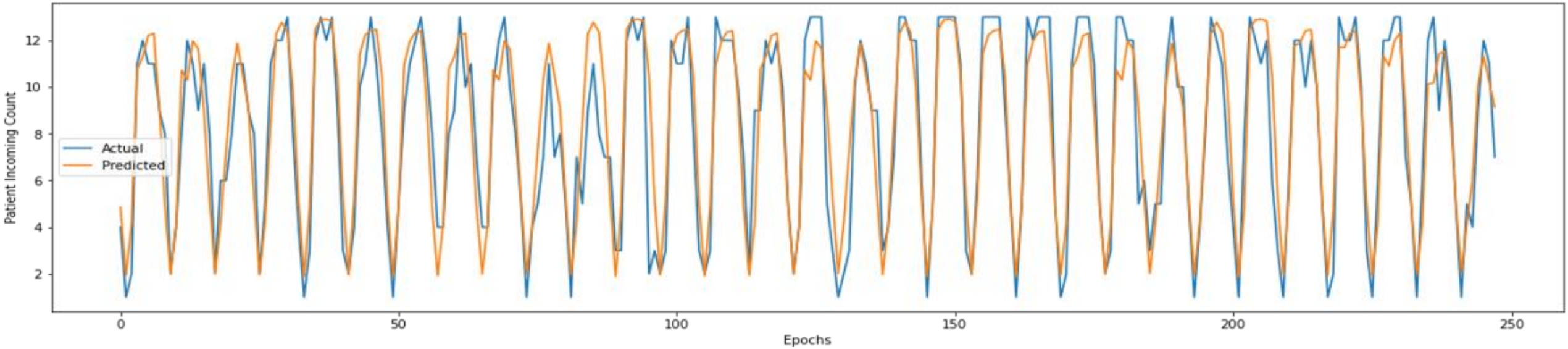

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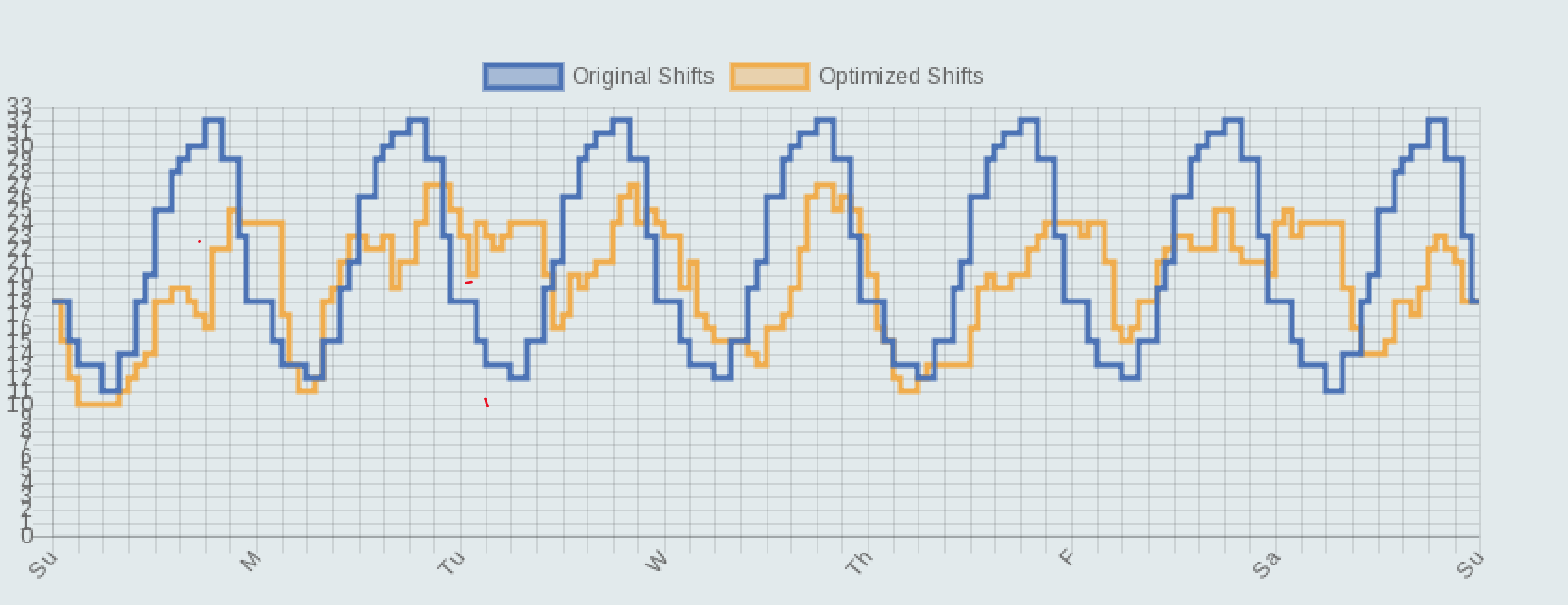
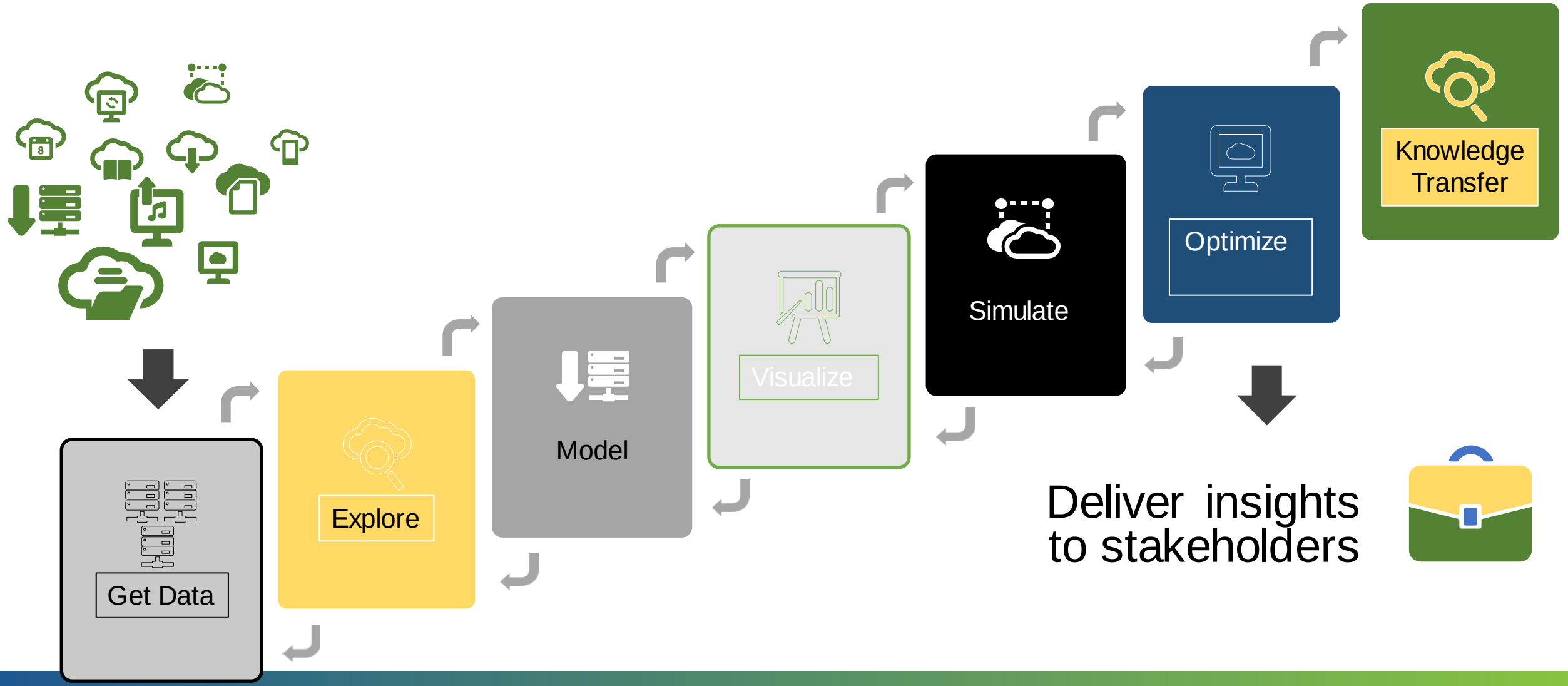
An example of Nurse Shift distribution pre and post Optimization



Methodology



Expected Operational Results

- Better sorting of patients and recognition of patterns in data results in more accurate resource planning
- Prediction of future bottle necks gives the operations team an early warning capability
- Simulation capability allows for manipulation of demand and capacity in a virtual environment and to evaluate the effects prior to implementing the changes
- AI and Machine learning searches for the most optimized combinations of staffing which is most often beyond the capabilities of a human mind
- Real time monitoring provides more visibility into the system now and in to the future
- The system empowers the operations team to be prospective and prescriptive instead of retroactive and reactive

Expected effect on Patient Care

- Less Patient wait time
- More timely diagnostics and therapeutics interventions
- Decreased length of stay
- Safer healthcare environment
- Less staff burn out
- More efficient use of scarce healthcare resources

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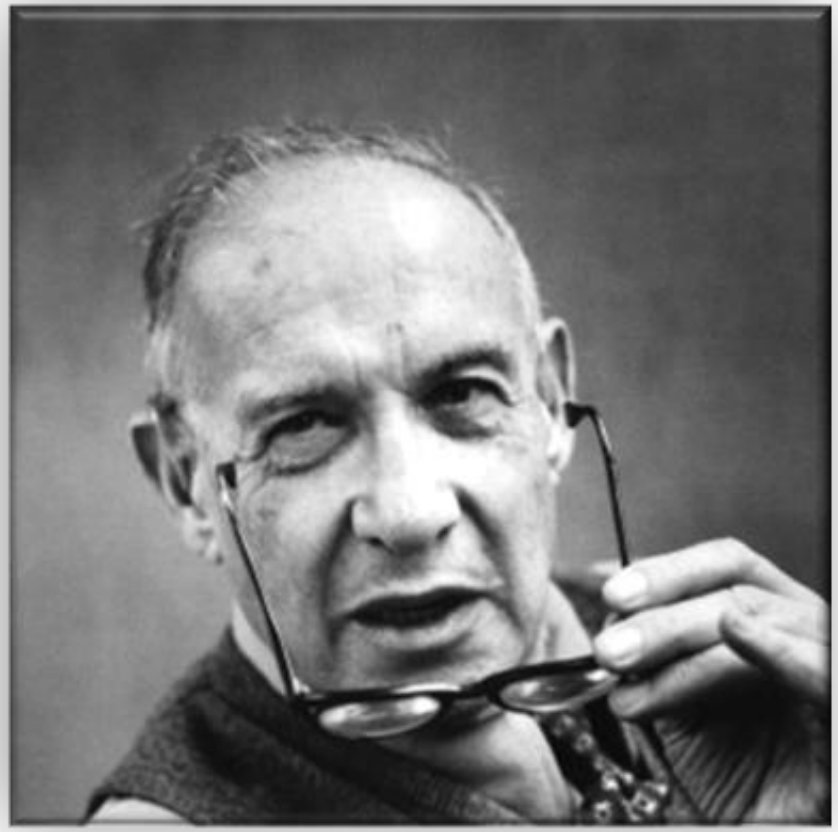
As Peter Drucker once noted:

“The best way to predict the future is to create it.”



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The Problem: Demand-Capacity mismatches cost American Healthcare System in excess of $100 billion per year. These mismatches result in delayed care, poor access, lost revenue and increased risk to American consumers.

Moving Us Into the Twenty-First Century…

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The Opportunity – We have available to us a comprehensive command center platform that leverages AI, Machine learning and Predictive Analytics to orchestrate the utilization of healthcare resources across the healthcare system.

We can help organizations match their capacity to the demand resulting in improved quality of care, increased patient access, reduced risk and the opportunity to reach peak performance systemwide.

The #1 Reason To Commit To This Is …

"It's good for our patients …
and it's good for
our people who take care of our patients…"

~ THOM MAYER, MD

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