



Machine Learning to Save Lives

H2O World – Mountain View

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INTEGRATED CARE DELIVERY



10 million members

the **Largest** integrated delivery system in the US

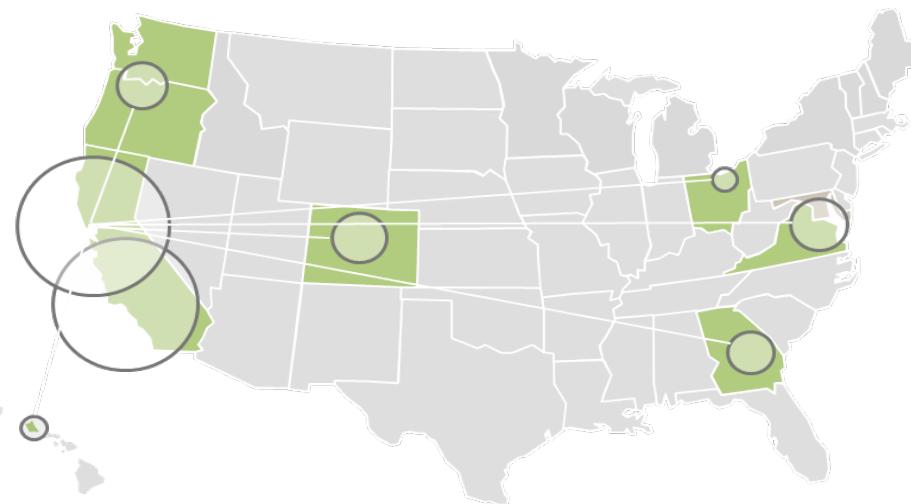
17,400 physicians

48,000 nurses

38 hospitals

608 medical offices and other outpatient facilities

\$56.4 billion operating revenue
(2014)



- integrated
- primary care
- specialty care
- home care
- hospital
- lab
- pharmacy
- optical
- dental
- insurance
- research

TECHNOLOGY INNOVATION ORIGINS



1960s | Dr. Sidney Garfield & Dr. Morris Collen

"We should begin to take advantage of electronic digital computers."



Supporting Health Care with Technology

"Continuing total health care requires a continuing life record for each individual...The content of that life record, now made possible by computer information technology, will chart the course to be taken by each individual for optimal health."

**Sidney Garfield, MD
Hospital Computer Systems, 1974**

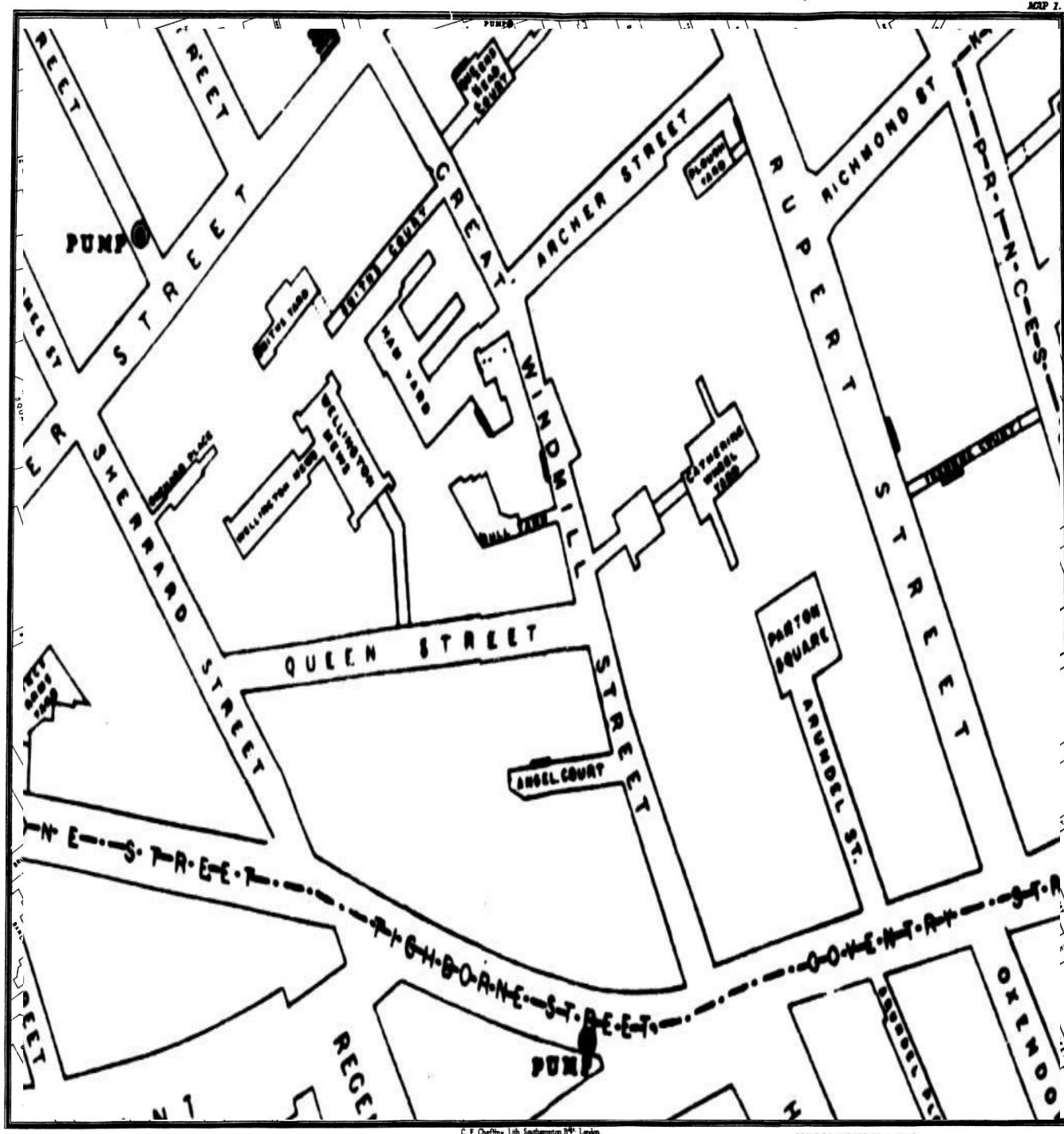


John Snow,
is the first
person in
recorded
history to
use data to
save lives



In 1854 there was a cholera outbreak in Soho, London. At that time, cholera was considered due to pollution or "bad air"

He took a map of Soho and started plotting the cases of Cholera.



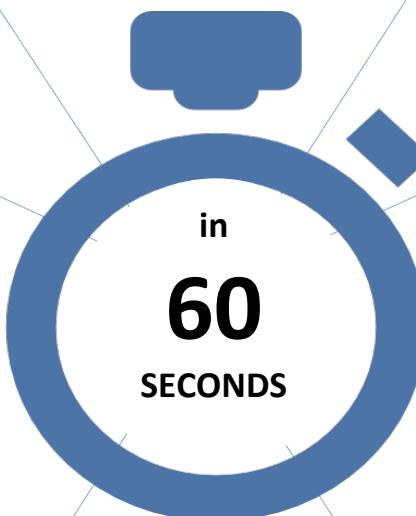


The (in)famous pump at Broad Street

Fast Forward 150 + years

2000

UNPRECEDENTED VOLUME OF PERSONAL DATA



370,000+



call minutes

695,000+



status updates

6 million+



text messages

694,445



search queries

1,300+



new mobile users

98,000+



tweets

100+ new



accounts

168 million



emails sent

13,000+



downloaded

600+ new



videos uploaded



We can still use data
to save lives !!

The Problem: Unplanned Transfers to the ICU

Multiple studies have shown that medical/surgical ward patients who deteriorate and have to be rapidly transferred to the ICU have increased morbidity and mortality

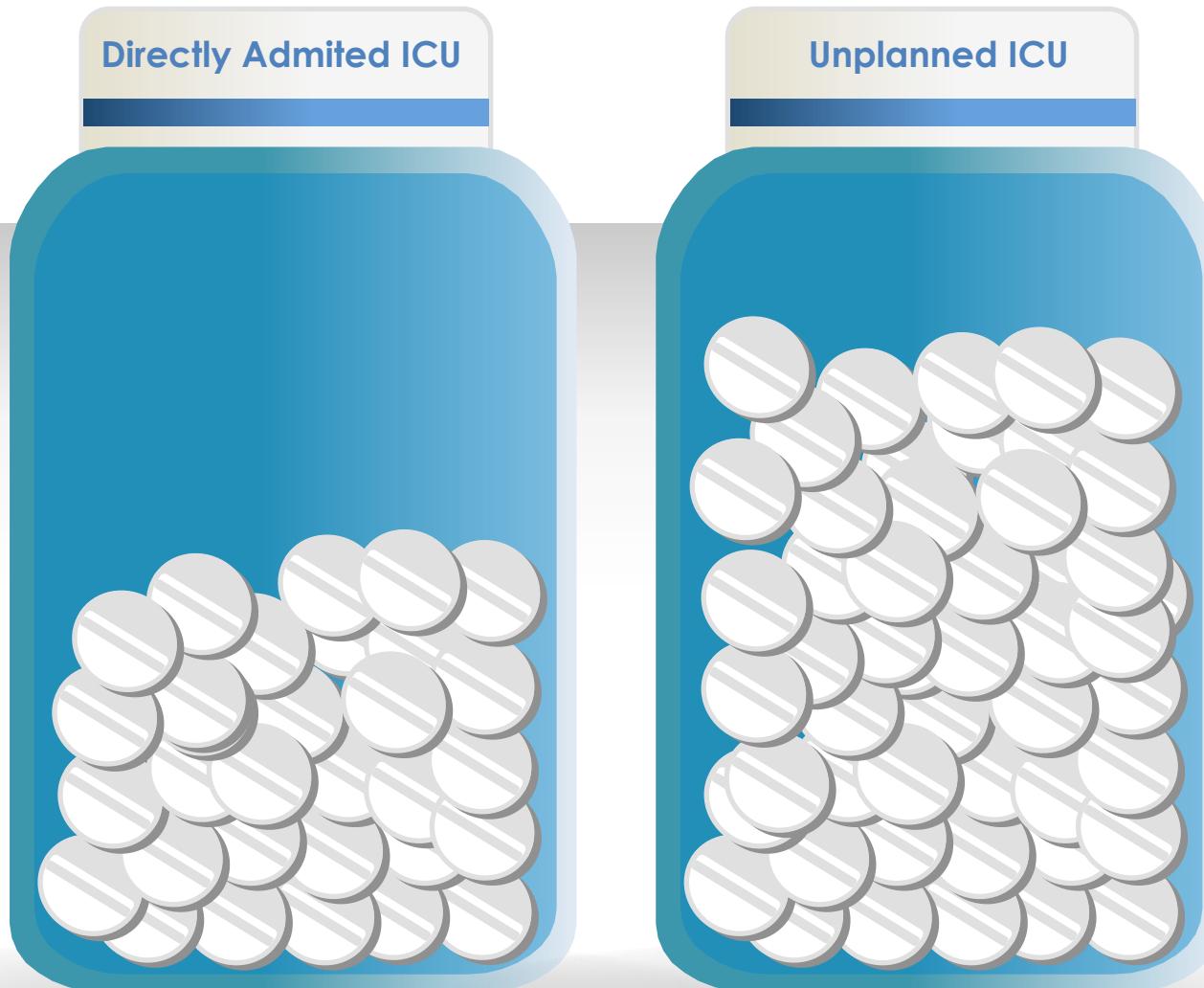
Frequency of Unplanned Transfer?

Unplanned transfer happens for 3% of in-patients

However Unplanned transfer to ICU's contribute to a mortality rate of 19.6%*



Mortality Rate



10.5%

19.6%

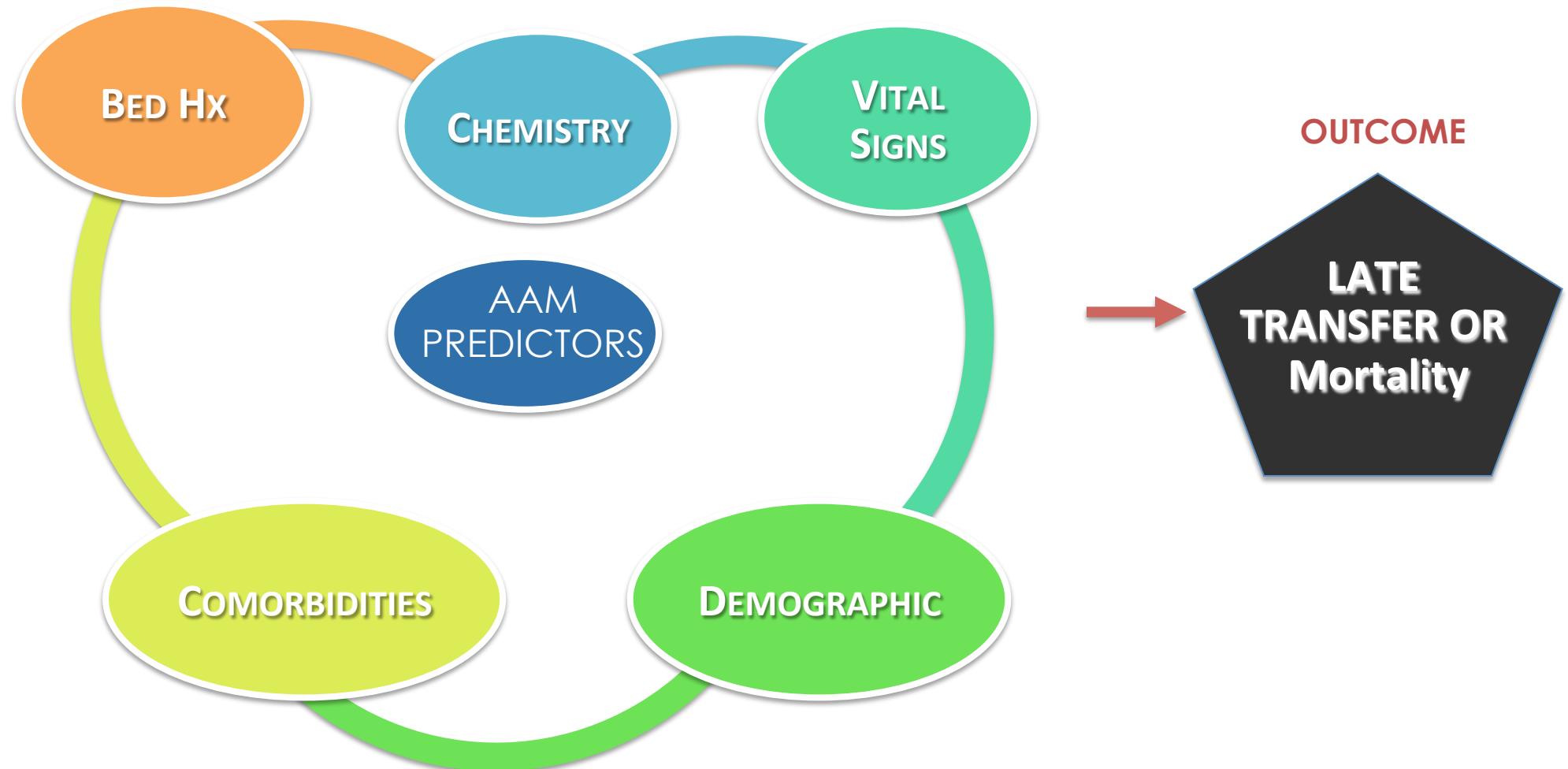
Early Warning Systems

- The concept of an early warning system (EWS) outside of health care is a familiar one
 - Earthquakes
 - Airplane crashes
 - Hurricanes
 - Fires
- They all try to reduce the risk of disaster by advance warning
- Medical/Surgical ward patients who are transferred to the intensive care unit (ICU) urgently show evidence of physiologic derangement **6 to 24** hours prior to their deterioration
- These clinical signs of deterioration are often missed by attending staff
- It seems intuitive to think that these unanticipated ICU admissions could be reduced if patients experiencing physiologic derangement were identified earlier and more systematically

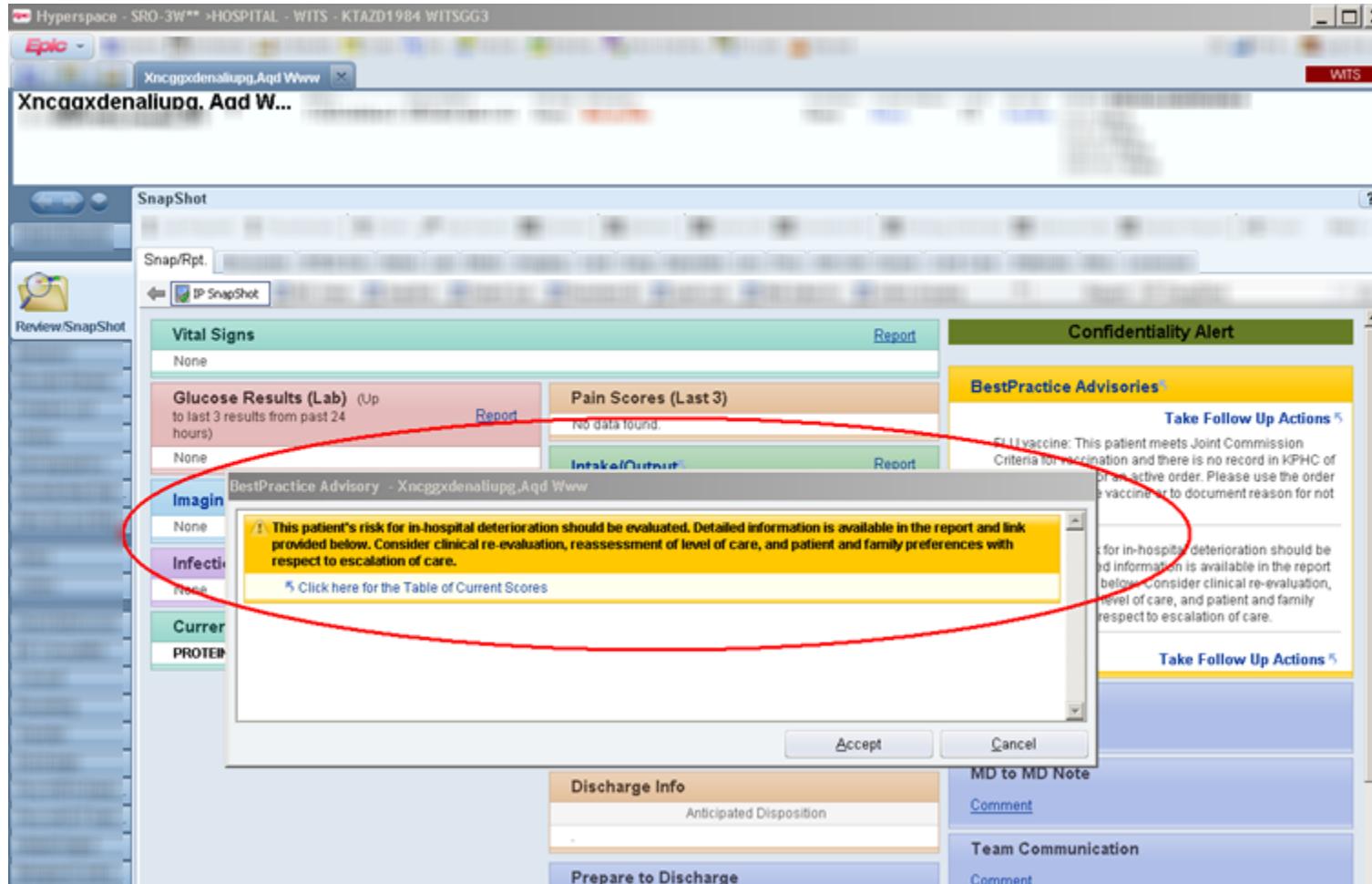
Unplanned ICU Transfers EWS

- There are a number of EWS that aim to prevent unplanned transfers to the ICU
- These are built on
 - Expert opinion
 - MEWS, NEWS, VitalPACTM, ViES, PEWS c_CHEWS
 - Statistical modeling
 - Rothman index
 - eCART
- We have developed a EWS called Advanced Alert Monitoring (AAM) at NCA KP to identify patients who are likely to “crash” in the next 12 hours
- A complete and effective early warning system has four main functions
 - Risk analysis
 - Monitoring and warning
 - Dissemination and communication
 - Intervention

Risk Analysis

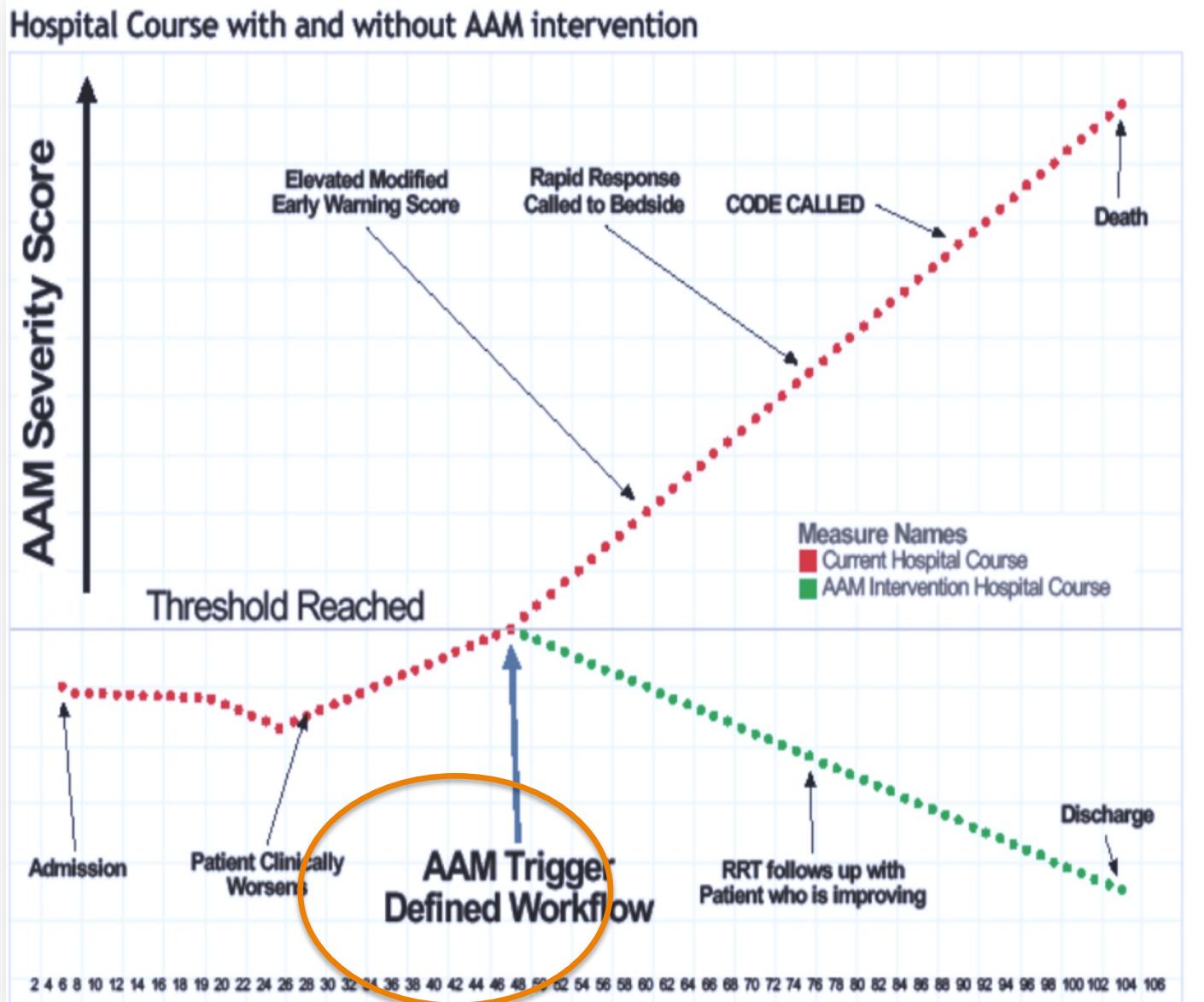


Monitoring and Warning

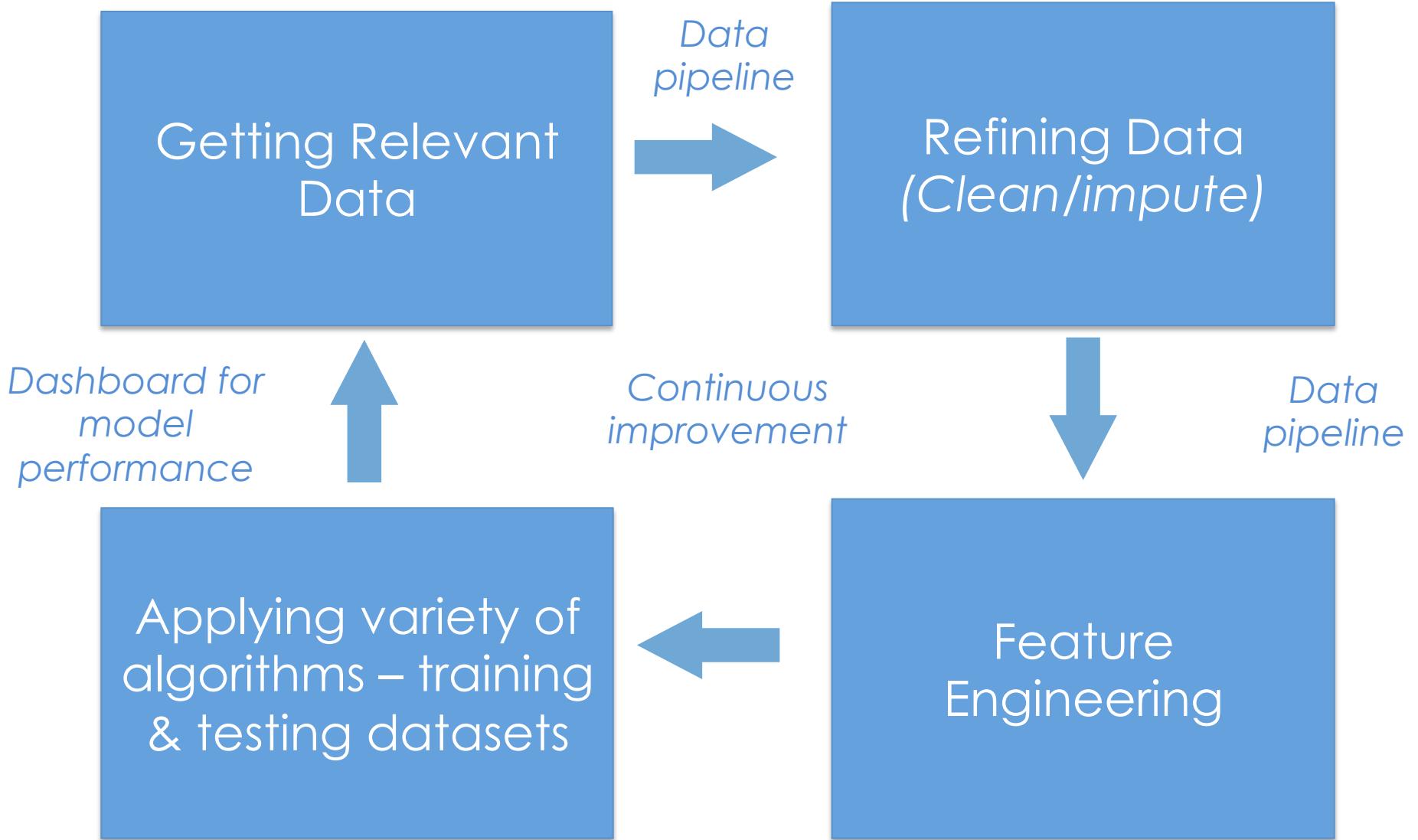


Upon Opening the Chart, a Pop-Up Alert Displays if AAM Exceeds Threshold

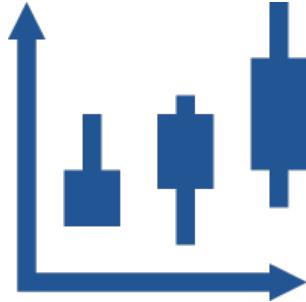
Respond to Alert



Developing the model



Validating the model using scoring data



We go through parameter exploration of each of the features used.



Clinicians review cases to see how the model performs and provide their feedback.



We do a characteristic review and threshold analysis.

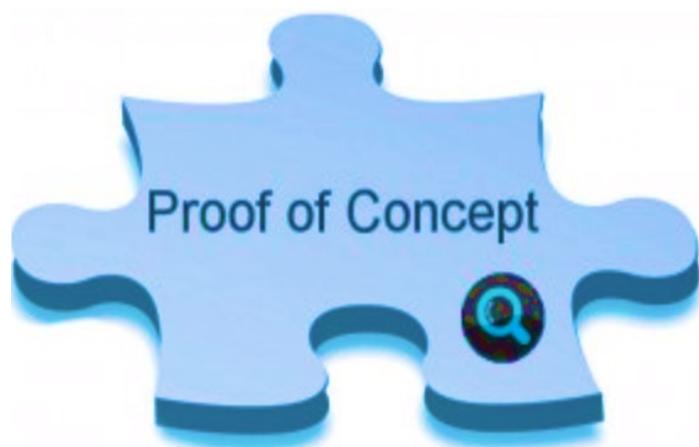
Productionalize the model



Healthcare is highly regulated industry, making it challenging to add and display new patient care information and putting these models into production



We did a POC to improve
the infrastructure,
processing time, tools &
leverage more recent
machine learning
algorithms and big data
tools available to us.



Learning

We improved overall model building process

- Faster access to data
- Faster processing
- Newer, & Better modeling algorithms,
- no sampling of data,
- easier to define and add new features,
- access to user friendly languages,
- open source

Use Case Challenges

The overall event rate is Low (3% of hospital admissions).

The event rate in narrow time periods (e.g. 12 hours) was extremely low.

Extreme care and highly involved testing is needed.

This is a classic class imbalance problem so we used Precision Recall & cost curves to compare various algorithms.

Next Steps

Continuously
improve – AB testing
& multi-arm bandit
tests

Look into new
features to be
added to our
training data-set.

Improve the
monitoring and
warning process

Compare all models
with Precision-Recall
Curves & Cost-
Curves

“The best minds
of my generation
are thinking about
how to make
people click ads.
That stinks.”

— Jeff Hammerbacher, Data Scientist



“The best minds
of my generation
are thinking
about using data
to Save lives.
That rocks !”

- *Sabrina Dahlgren, Director,
Decision Support, Kaiser*



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Health Care Needs you !!



Thank You !!