

Presented by:



# ACCELERATE AI EAST

BOSTON | April 30-May 4

# 2019

THE LEADING DATA SCIENCE CONFERENCE

#ODSC

BOSTON  
APR 30 – MAY 3

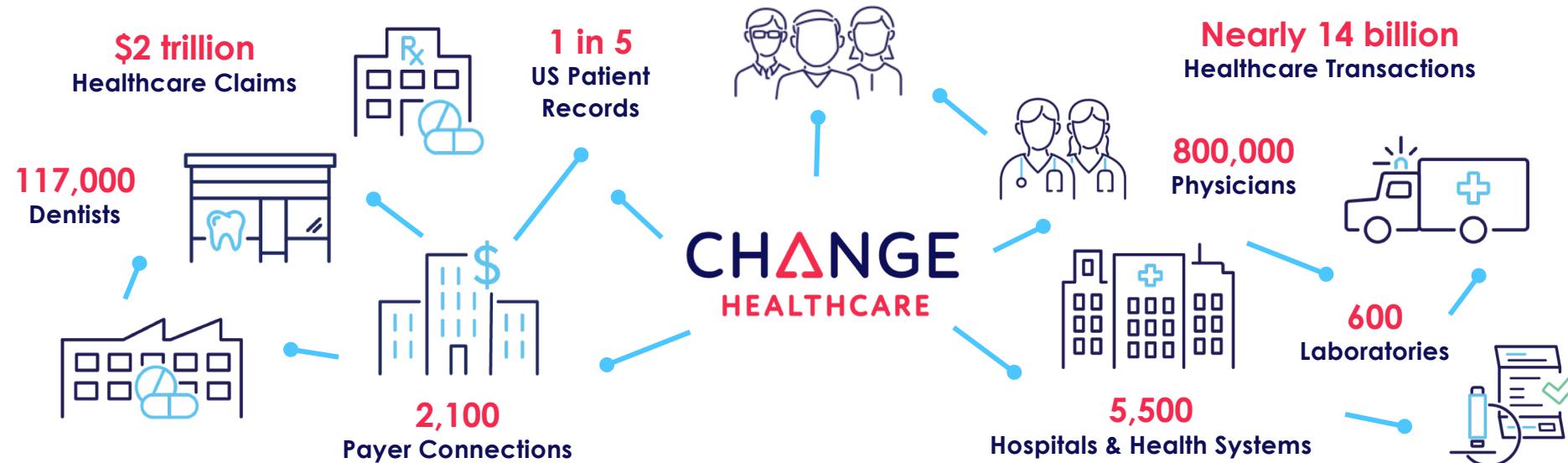
# Major Applications of AI in Healthcare

Alex Ermolaev

Director of AI,  
Change Healthcare



# The Change Healthcare Intelligent Healthcare Network...

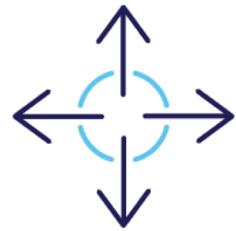


- Independent, unbiased, & relentless drive towards better healthcare
- Tying our success to our customer: providers, payers and consumers
- Extensive product/services, expertise, data, and connectivity
- Delivering practical innovation through technology and partners

Pervasive across healthcare

**CHANGE**  
HEALTHCARE

# AI Team Evolution



## Crawl

- Several data scientists spread across the company
- No leverage
- No visibility



## Walk

- CEO/Board commitment
- Pipeline of projects



## Walk Faster

- Rapid experimentation
- AI engineering
- One-click training and deployment



## Run

# Why Apply AI to Healthcare?

#1

US Industry by Revenue

#2

R&D Budget

#1

Most Important for Saving Lives

#1

Number of AI Opportunities

#1

Number of AI Startups

# Medical Intelligence

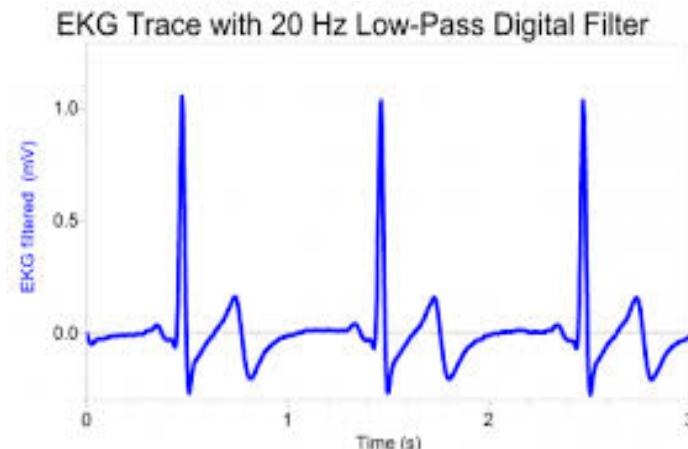
## Early Diagnosis and Disease Prediction

A screenshot of a medical software interface. At the top, there are tabs for Patient Summary, Medication History, Immunizations, Allergies & Adverse Reactions, Problems, Procedures, Lab History, Radiology History, and Clinical Documents. Below this is a toolbar with 'Print PDF' and 'View data sources and demographics' buttons, and a search bar. A green status bar indicates 'All data sources have responded.' The main area is titled 'Lab History' and shows a table of test results. The table has columns for Status, Test name, Result status, Collection date, Ordering provider, and Source. The results listed are:

Status	Test name	Result status	Collection date	Ordering provider	Source
Completed	Hemoglobin	Completed	01/12/2011	--	Good Healthcare
Final results	BLOOD ALCOHOL	Final results	10/23/2009	Grace Calahan R.	Good Lab
Completed	CBC WO DIFFERENTIAL	Completed	05/23/2009	--	Good Health
Completed	Lipid Profile	Completed	05/23/2009	--	Good Health
Completed	Electrolytes	Completed	05/23/2009	--	Good Health
Final results	CBC	Final results	05/23/2009	Alan Jones G	Good MN Laboratories
Final results	LIPID PROFILE	Final results	05/23/2009	Alan Jones G	Good MN Laboratories
Final results	ELECTROLYTES	Final results	05/23/2009	Alan Jones G	Good MN Laboratories
Completed	CBC WO DIFFERENTIAL	Completed	03/13/2008	--	Good Health
Completed	Urinalysis	Completed	03/13/2008	--	Good Health

Found: 11 results

## Health Monitoring Devices



## Computer-Aided Detection



# Sepsis Diagnostics

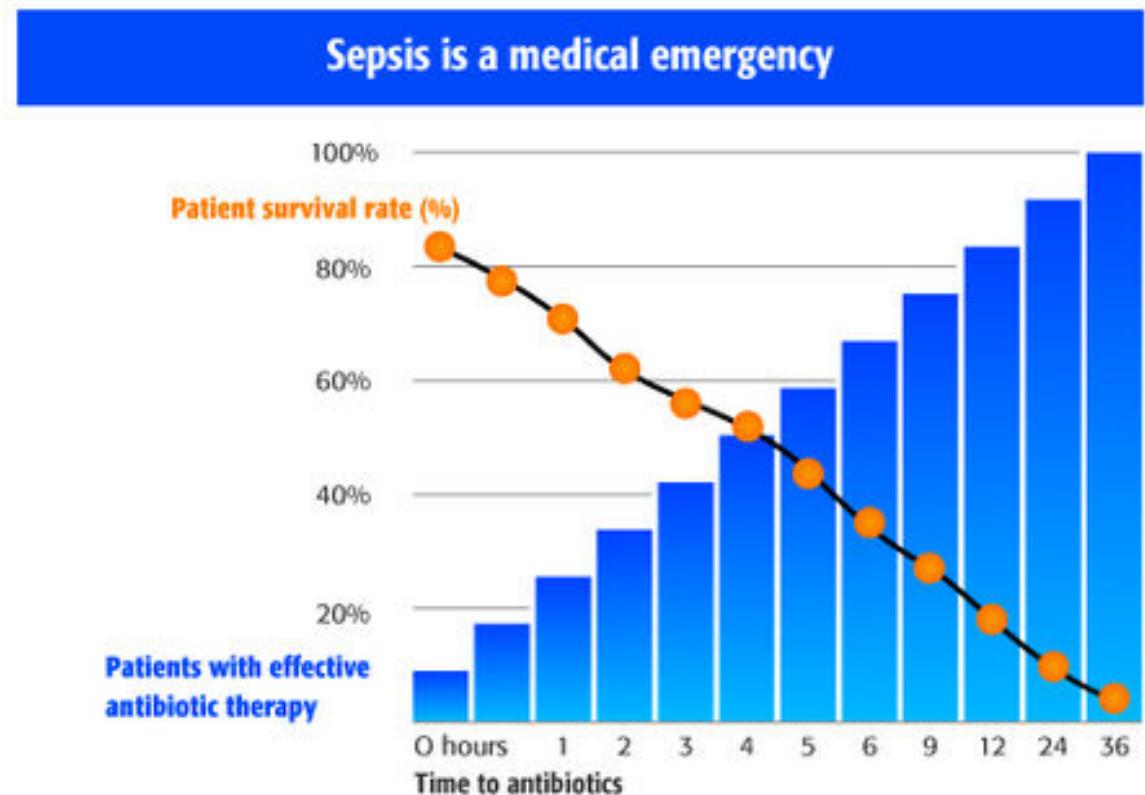
**1.6M** diagnoses/year (US)

**25%-30%** Mortality Rate

**#3** Cause of Death

**#1** Hospital Cost in US

Antibiotics increase survival rate  
**7.6%** per hour



Made for World Sepsis Day by lingruen-gmbh.com

**CHANGE**  
HEALTHCARE

# Sepsis Diagnostics (Continued)

## Applying Artificial Intelligence to Identify Physiomarkers Predicting Severe Sepsis in the PICU

Rishikesan Kamaleswaran, PhD<sup>1,2</sup>; Oguz Akbilgic, PhD<sup>1</sup>; Madhura A. Hallman, MD, MPH<sup>2</sup>; Alina N. West, MD, PhD<sup>2</sup>; Robert L. Davis, MD, MPH<sup>1</sup>; Samir H. Shah, MD, MBA, FRCPC<sup>2</sup>

---

**Objectives:** We used artificial intelligence to develop a novel algorithm using physiomarkers to predict the onset of severe sepsis in critically ill children.

**Design:** Observational cohort study.

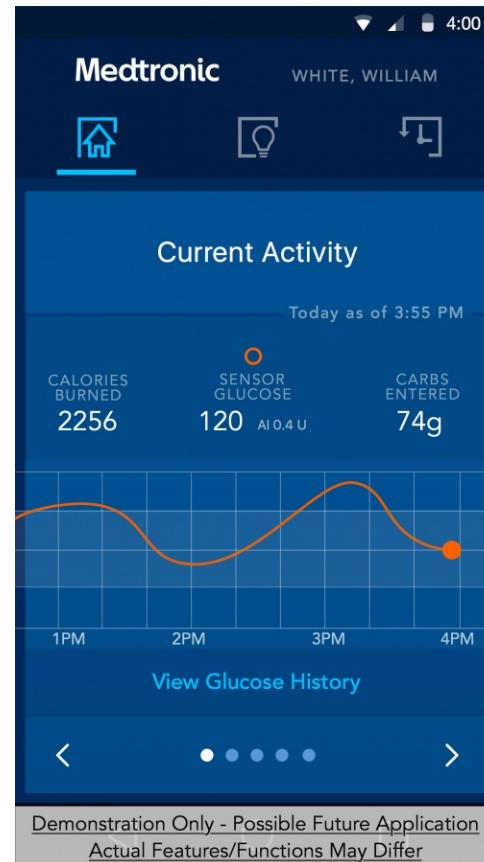
**Setting:** PICU.

**Patients:** Children age between 6 and 18 years old.

forest performed with 79.6% specificity and 80.0% sensitivity, and the Convolutional Neural Network performed with 83.0% specificity and 75.0% sensitivity. When analyzing physiomarkers from the 8–24 hours window, logistic regression resulted in 77.1% specificity and 39.3% sensitivity, random forest performed with 82.3% specificity and 61.1% sensitivity, whereas the Convolutional Neu-

Source: [https://www.researchgate.net/publication/326661039\\_Applying\\_Artificial\\_Intelligence\\_to\\_Identify\\_Physiomarkers\\_Predicting\\_Severe\\_Sepsis\\_in\\_the\\_PICU](https://www.researchgate.net/publication/326661039_Applying_Artificial_Intelligence_to_Identify_Physiomarkers_Predicting_Severe_Sepsis_in_the_PICU)

# Medical Devices



Built with your heart  
in mind.

Apple Watch Series 4 regularly monitors your heart throughout the day, so you can check your heart rate anytime and keep track of your heart's performance. What's more, if it detects unusually high or low heart rates, it alerts you — even when you don't feel symptoms.



# Workflow Intelligence.AI

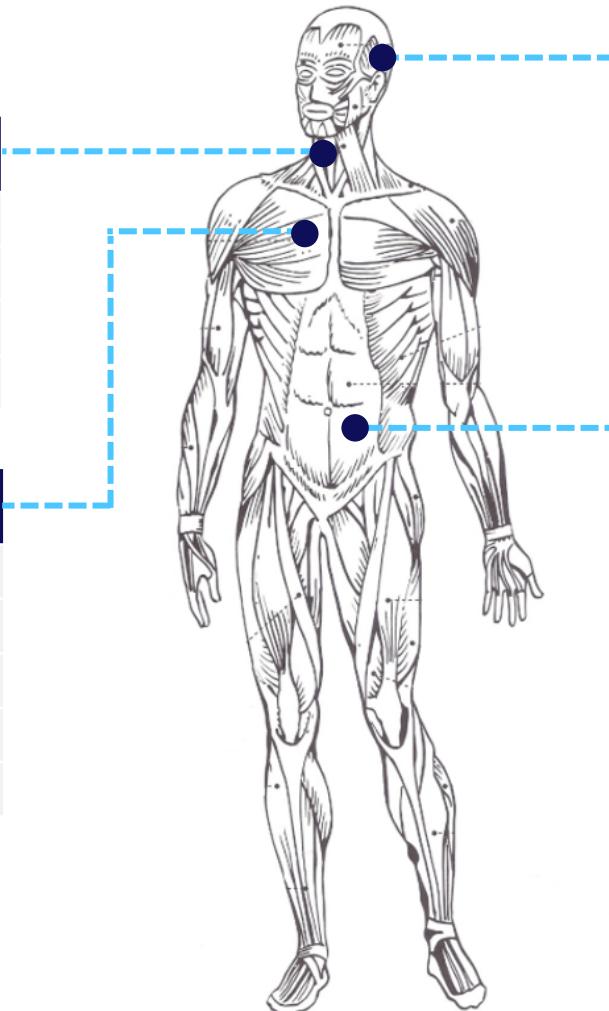
Intelligent Workflow driven by AI

## Neck

- Retropharyngeal abscess
- Spinal epidural hemorrhage
- Vertebral fracture
- Vertebral artery dissection

## Chest

- Pneumothorax
- Aortic dissection
- PE
- Spinal epidural hemorrhage
- Vertebral fracture



## Brain

- Subarachnoid Hemorrhage
- Subdural hemorrhage
- Extradural hemorrhage
- Intraventricular hemorrhage
- Parenchymal hemorrhage
- Hydrocephalus
- Midline shift
- Descending transtentorial herniation
- Ascending transtentorial herniation

## Abdomen

- Perforation / Free air
- Bowel obstruction
- Spinal epidural hemorrhage
- Vertebral fracture

# Personalization

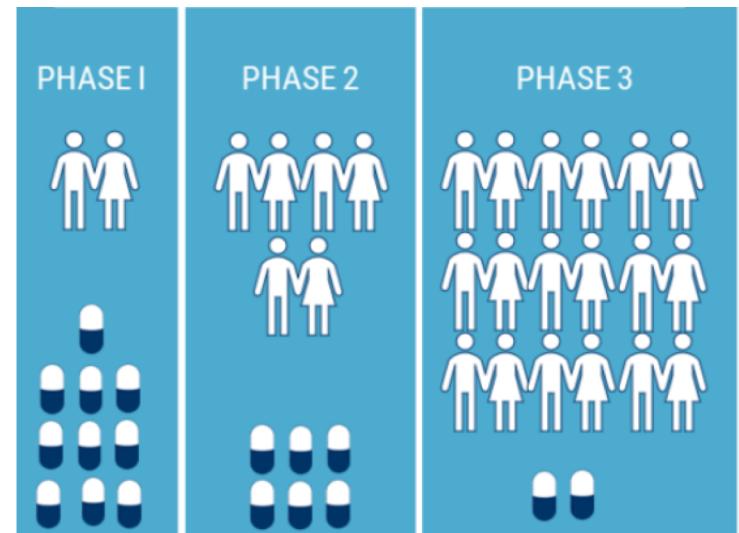
## Precision Medicine



## Personalized Treatment Plans



## Clinical Trials



# Personalized Treatment Plans

## Reinforcement Learning with Action-Derived Rewards for Chemotherapy and Clinical Trial Dosing Regimen Selection

Gregory Yauney

Pratik Shah\*

*Media Lab*

*Massachusetts Institute of Technology*  
*Cambridge, MA, USA*

GYAUNEY@MEDIA.MIT.EDU

PRATIKS@MEDIA.MIT.EDU

### Abstract

Unstructured learning problems without well-defined rewards are unsuitable for current reinforcement learning (RL) approaches. Action-derived rewards can allow RL agents to fully explore state and action trade-offs in scenarios that require specific outcomes yet are

Source: <https://www.media.mit.edu/publications/reinforcement-learning-for-designing-novel-clinical-trials-for-treating-cancer-patients/>



# Clinical Trials

## Oncology Trials

**3.4%**

of oncology clinical trials  
are completed

## Patients Enrolled

**5%**

of cancer patients are  
enrolled in clinical trials

"I don't think it's an unwillingness on the patients' part. I don't even think it's an unwillingness on the physician's part. It's really a system error..." Scott Delacroix, MD, told PBS NewsHour.

Sources: <http://blogs.sciencemag.org/pipeline/archives/2018/02/02/a-new-look-at-clinical-success-rates>  
<https://www.beckershospitalreview.com/quality/just-5-of-cancer-patients-participate-in-clinical-trials-5-things-to-know.html>



# Optimized Healthcare System

Smart Electronic  
Health records



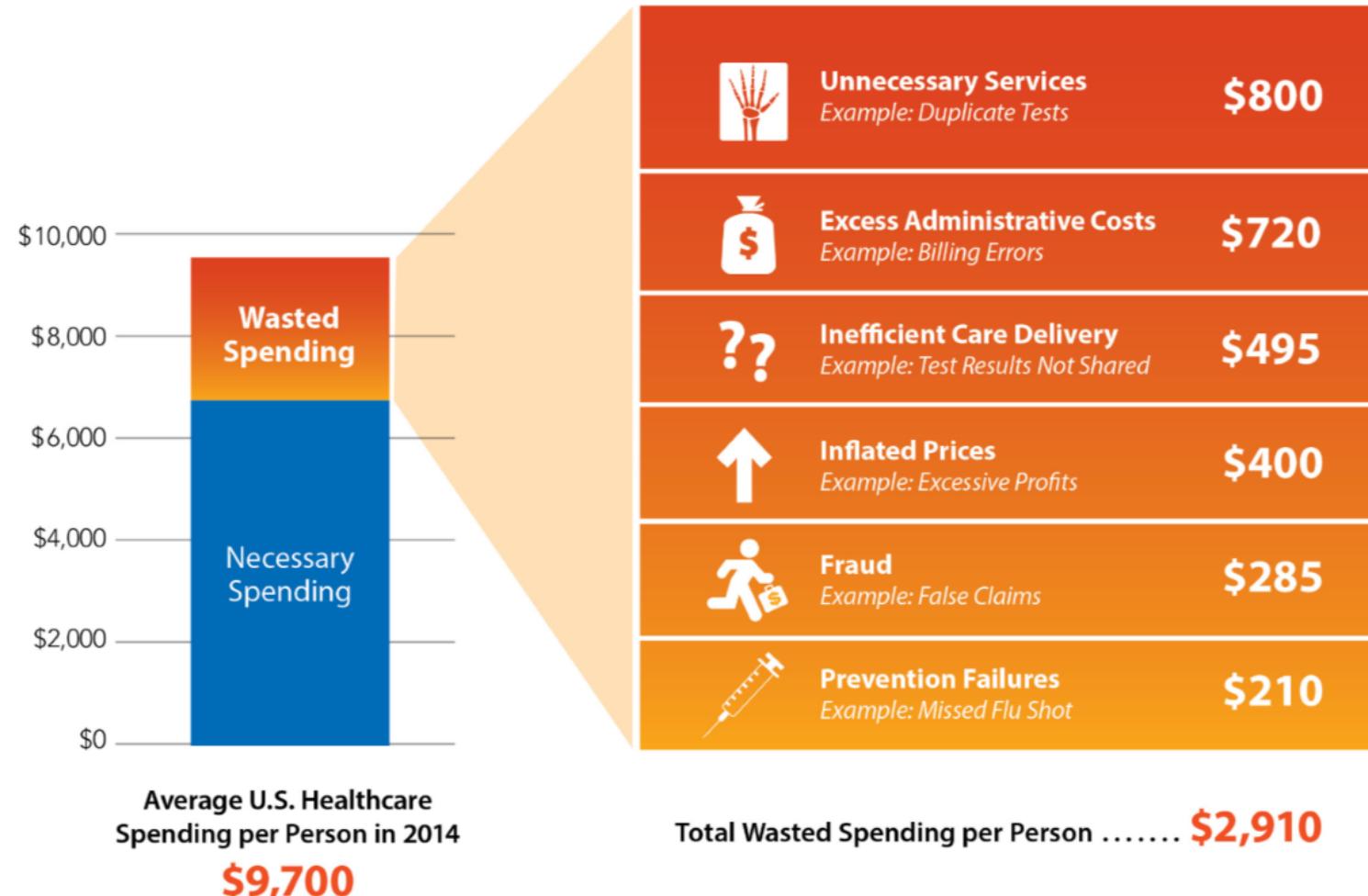
Transaction Accuracy  
And Streamlining



Patient Identification  
and Retention



# About 1/3 of Healthcare Spending is Wasted



Sources: <https://advocacy.consumerreports.org/research/engaging-consumers-on-health-care-cost-and-value-issues/>

# Medical Text Understanding

Page 1 of 2

## SOUTHWEST WASHINGTON MEDICAL CENTER DISCHARGE SUMMARY

ROLOFF, ELVINA M  
MR: 025-51-54

DOB: 11/07/1925  
ACCT: 0102304409

### REASON FOR ADMISSION:

New pleural effusion and altered mental status changes.

### DISCHARGE DIAGNOSES:

1. Metastatic adenocarcinoma, likely of lung origin.
2. Leukoencephalopathy.
3. COPD.

For the history of present illness, please see the admission history and physical as well as the multiple consulting notes.

### HOSPITAL COURSE:

Ms. Roloff was admitted and underwent thoracentesis. This resulted in some relief of her dyspnea. The pleural fluid revealed metastatic adenocarcinoma and CT scan of the chest showed mediastinal adenopathy. A specific primary tumor was not definitively shown during this hospital stay, but it was presumed this was metastatic adenocarcinoma from the lung given her smoking history. She had a chest tube placed with drainage of her pleural effusion and a pleurodesis.

MRI of the brain revealed multiple lesions in the brain, which were not metastatic disease and felt to be a perineoplastic leukoencephalopathy. Her mental status did not change significantly in the hospital, she remained somewhat confused.

Long discussions were carried out with her daughter, and a palliative supportive care plan was put in place. She was discharged with Hospice assistance at home and the care of her daughter.

### DISCHARGE MEDICATIONS:

Lisinopril 10 mg q day.  
Flovent two puffs q.i.d.  
Serevent two puffs b.i.d.

#### PATIENT IMPRINT

ROLOFF, ELVINA M  
025-51-54 11/07/1925  
0102304409 IP  
ADM: 01/23/2001 DIS: 02/03/2001  
DAVID A. SMITH, M.D.  
EXPECTED ADM:  
KHRN:

#### SOUTHWEST WASHINGTON MEDICAL CENTER

- MEDICAL CENTER CAMPUS  
 MEMORIAL CAMPUS

#### DISCHARGE SUMMARY

Header ✓

Member info ✓

Likely diagnoses ✓

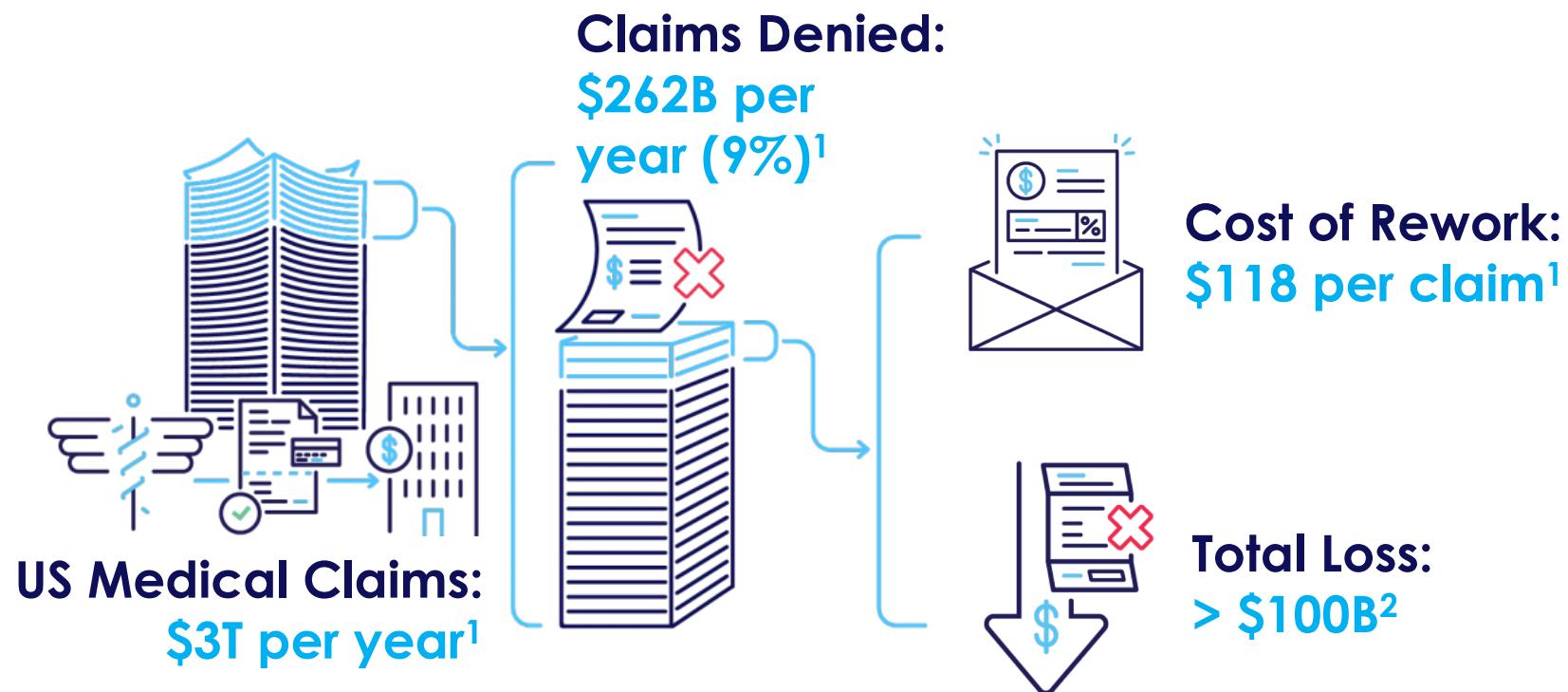
Footer ✓

David A. Smith, M.D. ✓

Legalese ✓

CHANGE  
HEALTHCARE

# Problem: Medical Claims



1. Source: <https://www.businesswire.com/news/home/20170626005391/en/Change-Healthcare-Analysis-Estimated-262-Billion-Healthcare>  
2. Source: Change Healthcare Internal Statistics

# Example: Dual Enrollment

Today  
**58.8M**  
Medicare beneficiaries

Live at or below  
**34%**  
of the federal poverty level

And only  
**10.6M**  
are dual-enrolled

1 - CMS Fast Facts, January 2018: <https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/CMS-Fast-Facts/index.html>

2- Kaiser Family Foundation: <https://www.kff.org/medicare/state-indicator/medicare-beneficiaries-by-fpl/?currentTimeframe=0&sortModel=%7B%22colId%22:%22Location%22,%22sort%22:%22asc%22%7D>

3- CMS, <https://www.cms.gov/Medicare-Medicaid-Coordination/Medicare-and-Medicaid-Coordination/Medicare-Medicaid-Coordination-Office/DataStatisticalResources/Data-and-Statistical-Resources.html>

# AI in Healthcare Summary

## Medical Intelligence

## Personalization

## Optimized Healthcare System

Patient Summary									
Medication History		Immunizations		Allergies & Adverse Reactions					
Problems		Procedures		Lab History					
Print PDF   View data sources and demographics									
Find new patient   ?									
All data sources have responded.									
Lab History									
Search   Show all									
Status Test name Result status Collection date + Ordering provider Source									
Completed	Hemoglobin	Completed	01/12/2011	—	Good HealthCare				
Completed	BLOOD ALCOHOL	Final results	1/12/2009	Grace Cahan R	Good Lab				
Completed	CBC (W/D DIFFERENTIAL)	Completed	01/23/2009	—	Good Health				
Completed	Lipid Profile	Completed	01/23/2009	—	Good Health				
Completed	BreastExam	Completed	01/23/2009	—	Good Health				
—	CBC	Final results	01/23/2009	Alan Jones G	Good MRI Laboratories				
Completed	URO PROFILE	Final results	01/23/2009	Alan Jones G	Good MRI Laboratories				
Completed	ELECTROLYTES	Final results	01/23/2009	Alan Jones G	Good MRI Laboratories				
Completed	CBC (W/D DIFFERENTIAL)	Completed	01/13/2008	—	Good Health				
Completed	Lead levels	Completed	01/13/2008	—	Good Health				

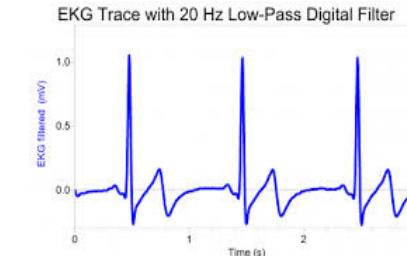
## Early Diagnosis



## Precision Medicine



## Smart Electronic Health records



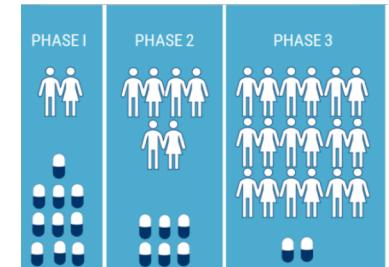
## Health Monitoring



## Personalized Treatment Plans



## Medical Imaging



## Clinical Trials



## Payment Accuracy



## Patient Identification and Retention

**CHANGE**  
HEALTHCARE

# Healthcare AI Startups

100 Artificial Intelligence Startups Transforming Healthcare

## Clinical Trials & Drug Discovery



## Insights & Risk Analytics



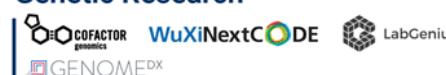
## Nutrition



## Connected Devices



## Genetic Research



## Imaging & Diagnostics



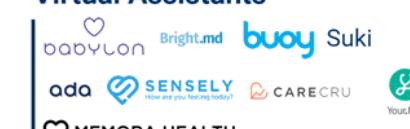
## Lifestyle Mgmt & Monitoring



## Mental Health



## Virtual Assistants



## ER & Hospital Management



Created by You. Powered by CB INSIGHTS

Source: CBInsights

\*The map is not exhaustive of all the startups in the space, and only includes companies that raised a VC or corporate-backed equity deal after January 2017

# AI in Healthcare Challenges

Embrace  
Variety

Respect  
Data

Understand  
Workflow

“In order to understand **trust** in the relationship between humans and automation, we have to explore **trust** in two dimensions: **trust** in the technology and **trust** in the innovating firm.”

Source: <https://hbr.org/2017/04/to-get-consumers-to-trust-ai-show-them-its-benefits>



# Thank You!

