Optimizing the value of advanced analytics for value-based care:

Making data clinically meaningful and integrating workflow

Basit Chaudhry MD, PhD

June 18, 2019

Agenda

01 Applying human-machine collaboration in healthcare

02 Tuple Health overview

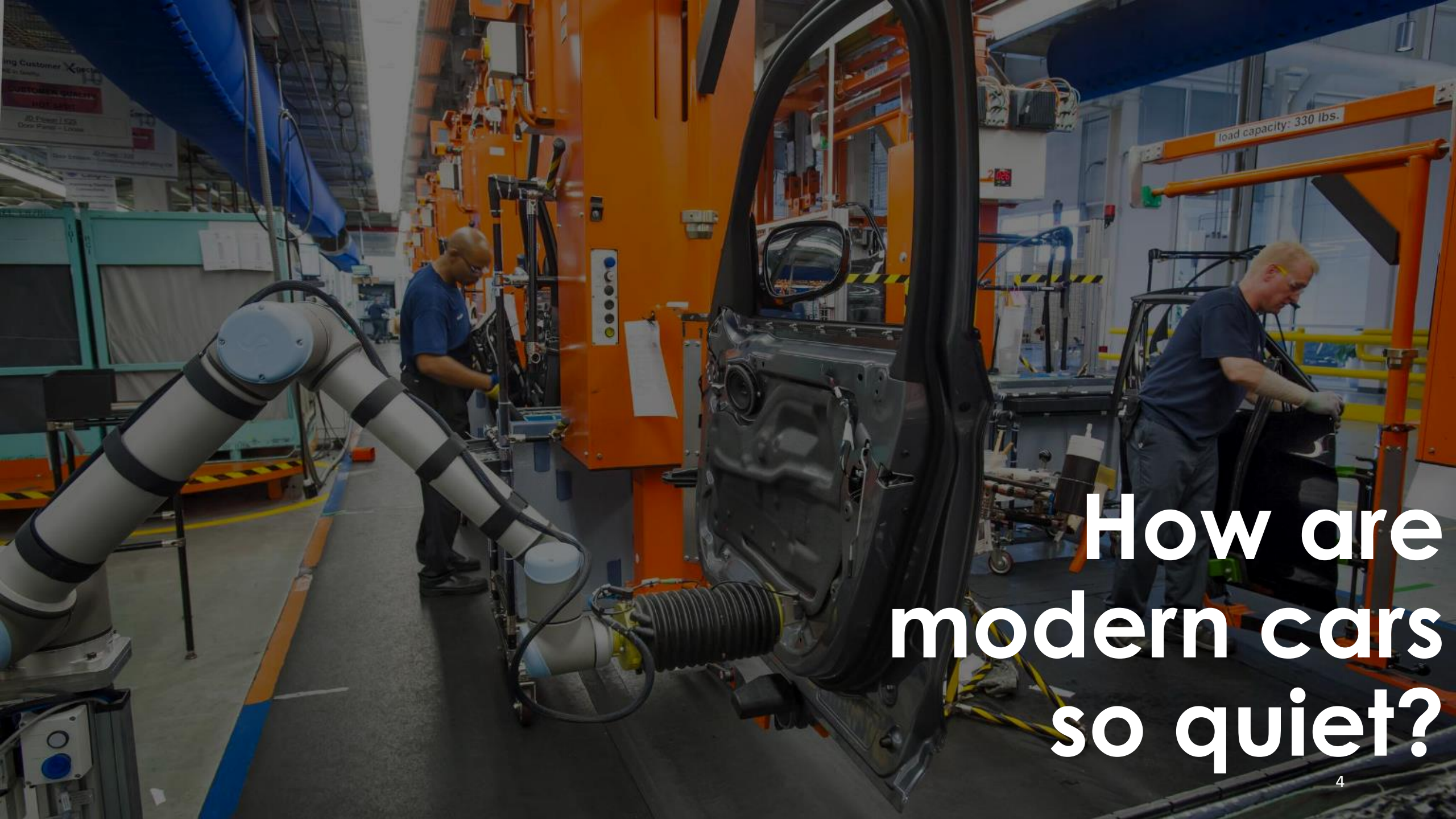
03 How we're building tools for human-machine collaboration

Agenda

01 Applying human-machine collaboration in healthcare

02 Tuple Health overview

03 How we're building tools for human-machine collaboration



How are modern cars so quiet?

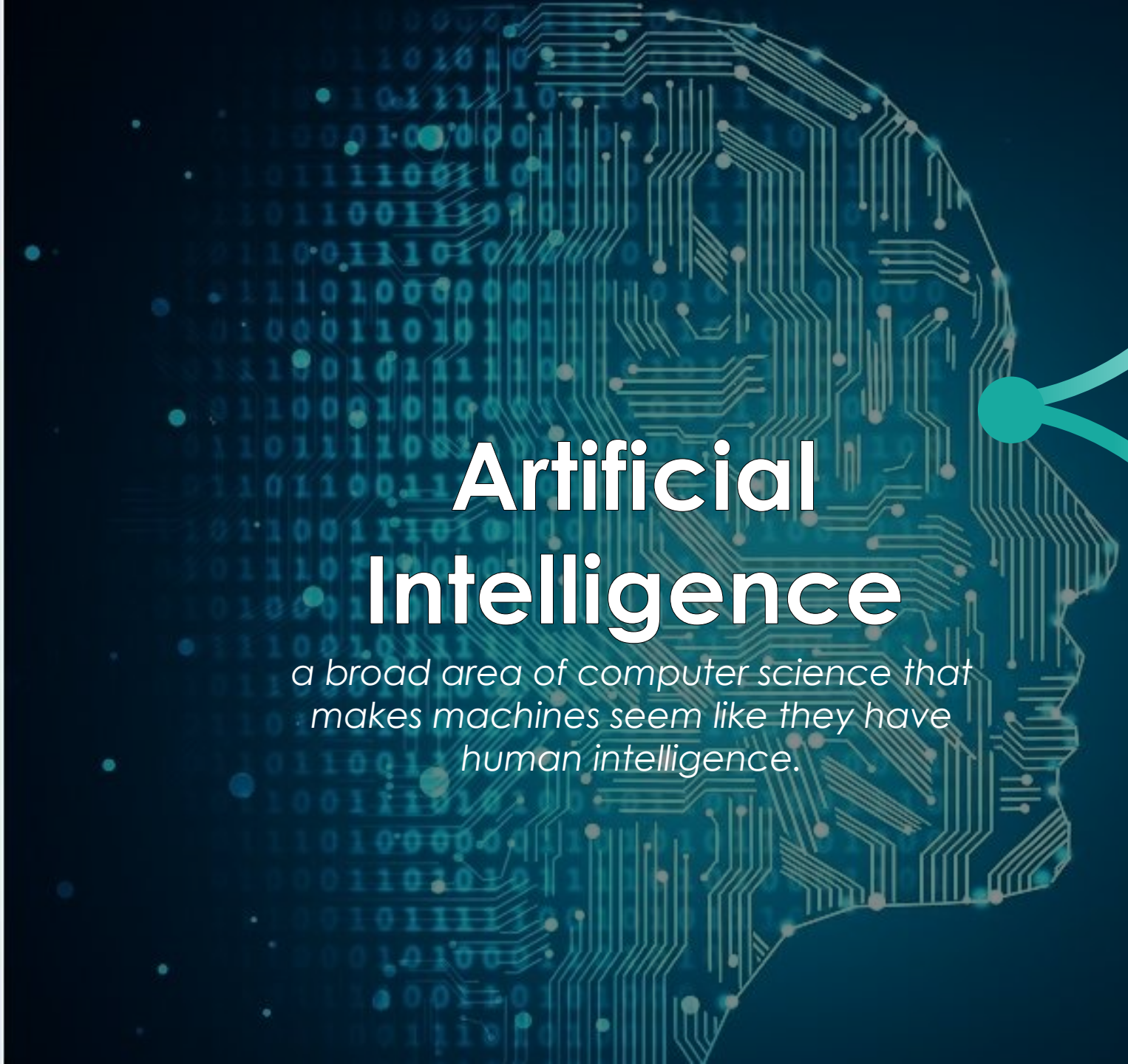
End-to-end lung cancer screening with three-dimensional deep learning on low-dose chest computed tomography

Diego Ardila, Atilla P. Kiraly, Sujeeth Bharadwaj, Bokyung Choi, Joshua J. Reicher, Lily Peng, Daniel Tse ✉, Mozziyar Etemadi, Wenxing Ye, Greg Corrado, David P. Naidich & Shravya Shetty

Nature Medicine **25**, 954–961 (2019) | Download Citation ⬇

Abstract

With an estimated 160,000 deaths in 2018, lung cancer is the most common cause of cancer death in the United States[1]. Lung cancer screening using low-dose computed tomography has been shown to reduce mortality by 20–43% and is now included in US screening guidelines[1,2,3,4,5,6]. Existing challenges include inter-grader variability and high false-positive and false-negative rates[7,8,9,10]. We propose a deep learning algorithm that uses a patient's current and prior computed tomography volumes to predict the risk of lung cancer. Our model achieves a state-of-the-art performance (94.4% area under the curve) on 6,716 National Lung Cancer Screening Trial cases, and performs similarly on an independent clinical validation set of 1,139 cases. We conducted two reader studies. When prior computed tomography imaging was not available, our model outperformed all six radiologists with absolute reductions of 11% in false positives and 5% in false negatives. Where prior computed tomography imaging was available, the model performance was on-par with the same radiologists. This creates an opportunity to optimize the screening process via computer assistance and automation. While the vast majority of patients remain unscreened, we show the potential for deep learning models to increase the accuracy, consistency and adoption of lung cancer screening worldwide.



Artificial Intelligence

a broad area of computer science that makes machines seem like they have human intelligence.

General AI

AI that exhibits human intelligence and can successfully perform any intellectual task that a human being can.

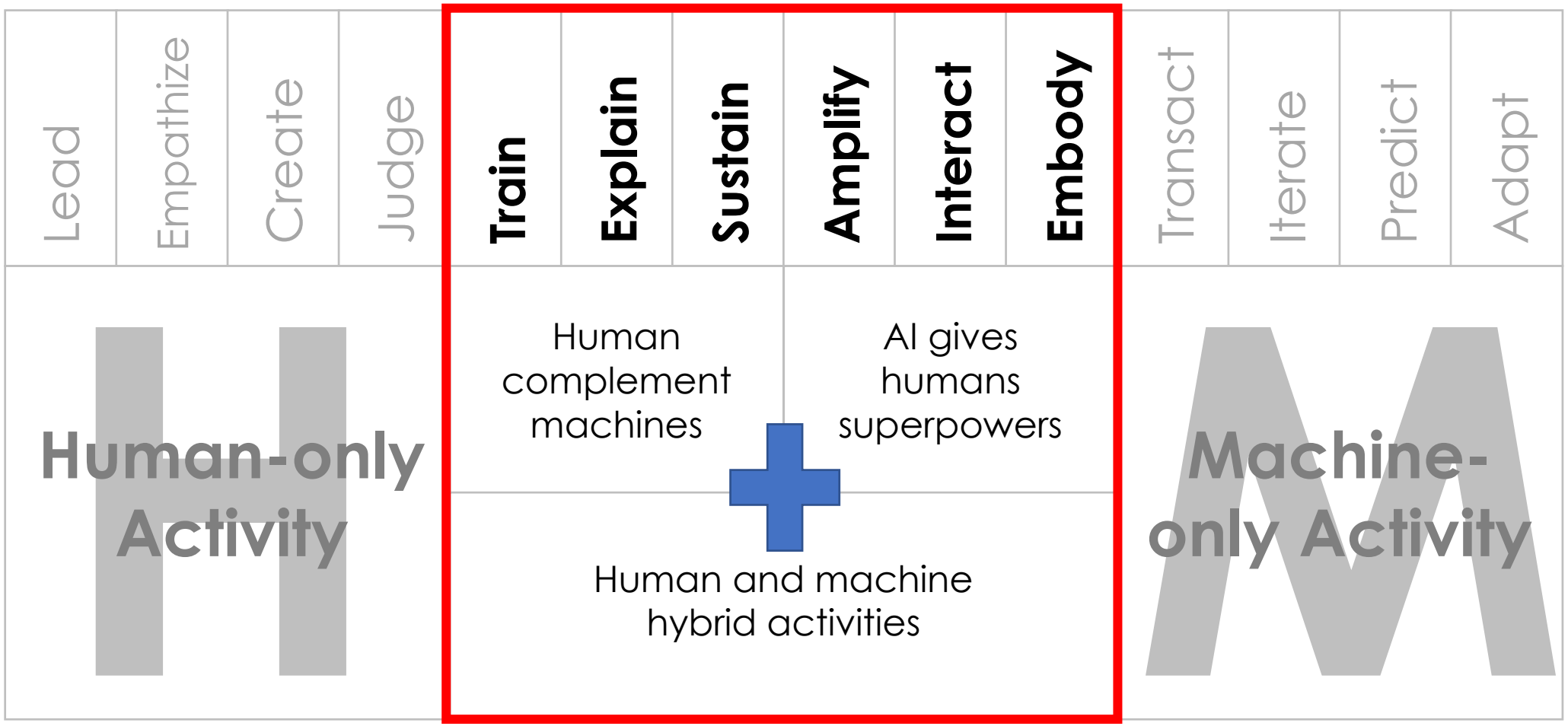
Narrow AI

AI that is programmed to perform a single task—whether it's checking the weather, being able to play chess, or analyzing raw data to write journalistic reports.

Men will set the goals, formulate the hypotheses, determine the criteria, and perform the evaluations. Computing machines will do the routinizable work that must be done to prepare the way for insights and decisions in technical and scientific thinking. . . . *The symbiotic partnership will perform intellectual operations much more effectively than man alone can perform them.*

Dr. Joseph Carl Robnett Licklider

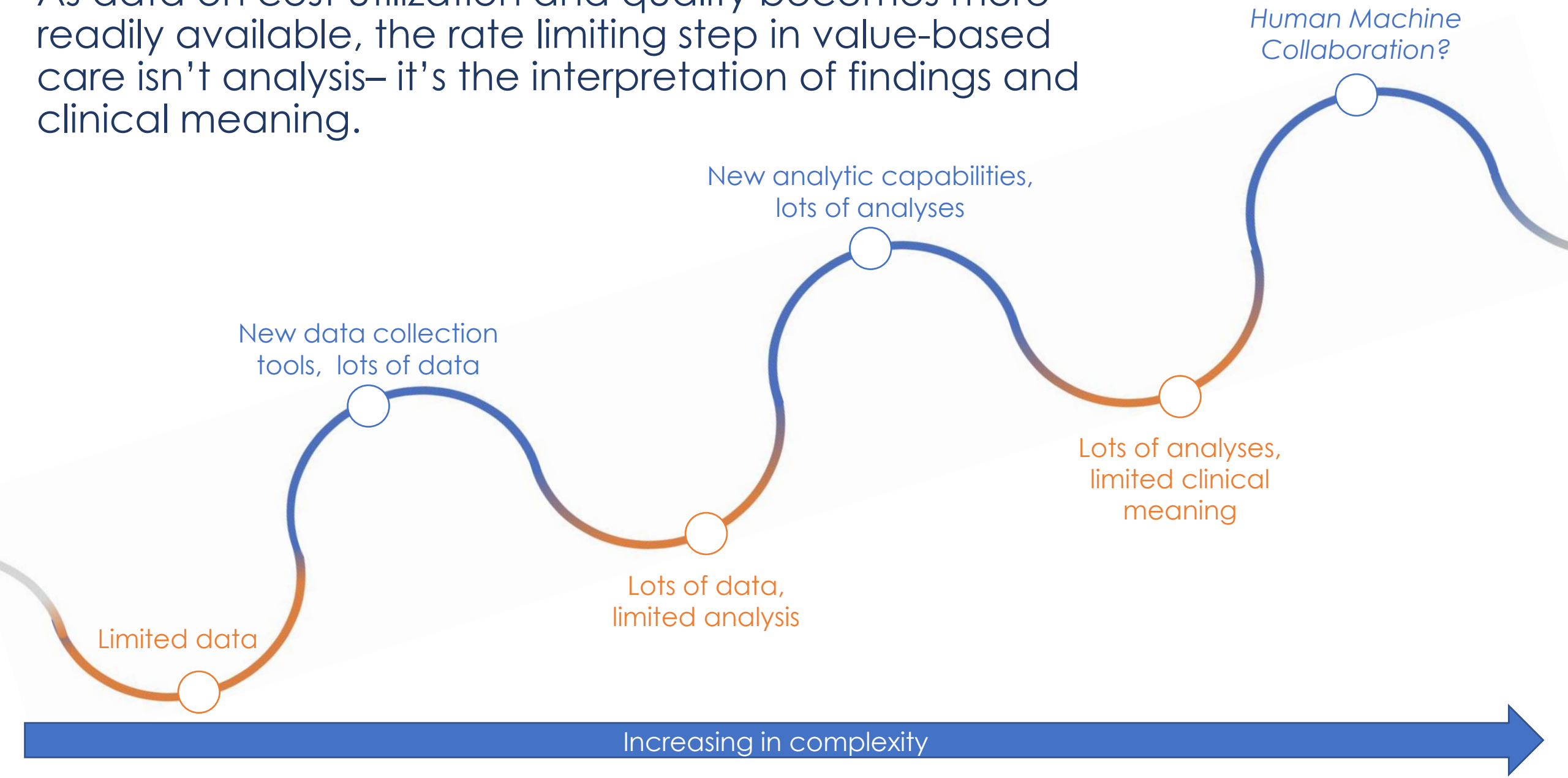
Human-machine collaboration



Source: Wilson, J., Daugherty, P., *Human + Machine: Reimagining Work in the Age of AI*, June 2018

Where are we in value-based care and technology?

As data on cost utilization and quality becomes more readily available, the rate limiting step in value-based care isn't analysis– it's the interpretation of findings and clinical meaning.



At this point of intersection between technology and data, the limitation isn't access to data, but the ability to interpret findings and build clinical meaning.

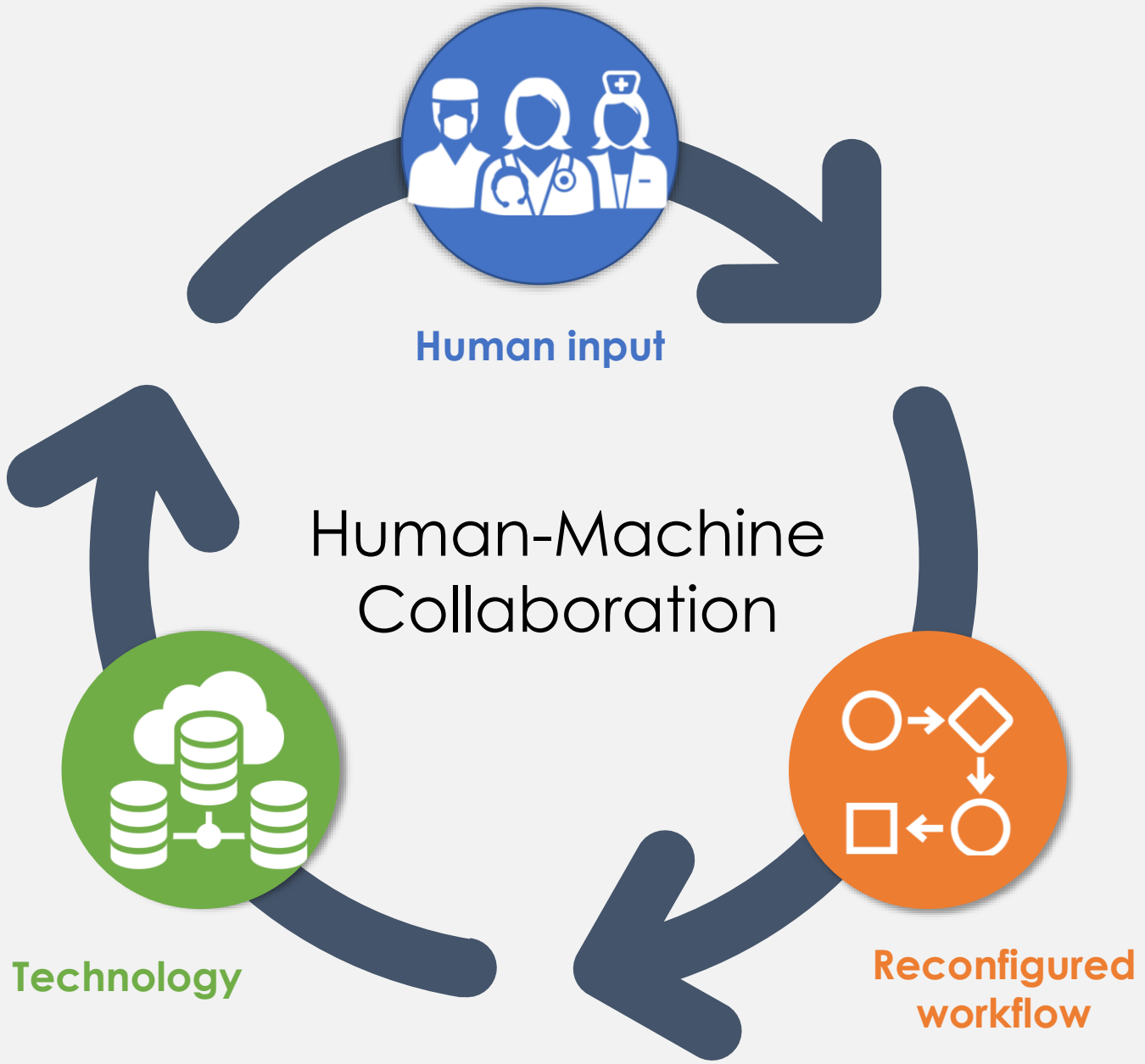
This will be critical for providers to be successful in a VBP model– interpreting data in a way that drives behavior change amongst front line providers.

For physicians, how actionable data is depends on how clinically meaningful they find it.

Reorganizing data structures around physician mental models provides more clinical utility and creates the foundation for more complex analytics.

AI in healthcare is about Human-Machine Collaboration.

Providing physicians and care teams with tools that build their clinical intuition and reduce cognitive burden and friction.



Agenda

01 Applying human-machine collaboration in healthcare

02 Tuple Health overview

03 How we're building tools for human-machine collaboration

Tuple Health partners closely with organizations on their transformation process. We deeply understand their perspectives & needs by combining services and product.

IMPLEMENTATION

- Interpreting cost, utilization & quality data & mapping insights to clinical implementation
- Practice diagnostic to understand areas for improvement in oncology care
- Organizational modeling
- Analysis and interpretation of policy and methodology in OCM and other care models related to oncology
- Scaling clinical excellence & professional insight

PRODUCT

- Re-organizing & analyzing payer/CMS data to maximize insights for practices
  - Embedded into deep clinical knowledge, practice transformation experience, understanding of programs & policies
- Integrate clinical data + financial
- Customized product reflecting local context and organizational workflows
- Leveraging top development talent to produce high quality technology
- A human-first approach to design
- Continuous improvement

COMPREHENSIVE PRACTICE TRANSFORMATION & MANAGEMENT OF RISK EXPOSURE

A combined approach designed to build a clinical enterprise and drive transformation

Tuple Health understands practice transformation and value based payment from the inside out.

Clinical Knowledge

Value-Based Payment Experience

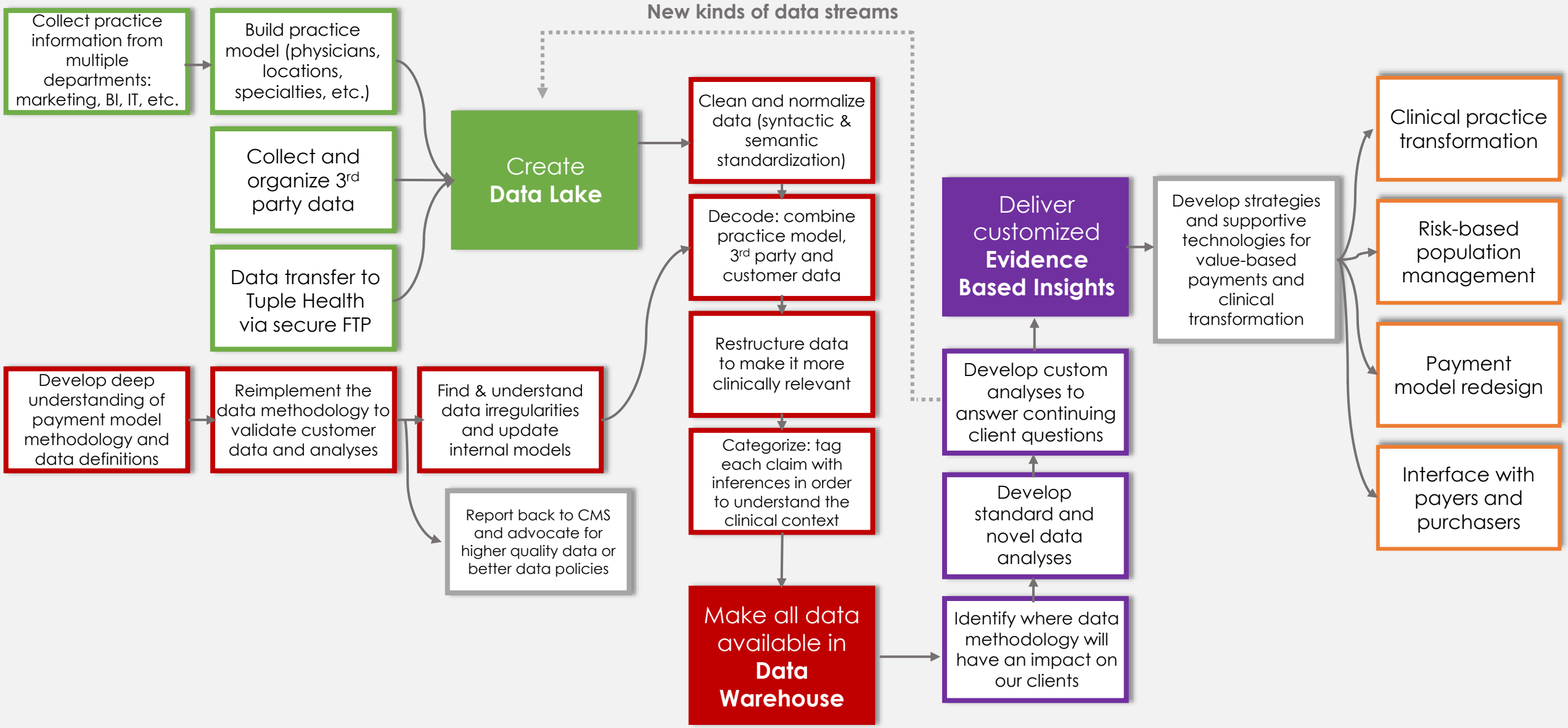
Practice Reengineering Expertise

Human-Centered Design Methodology
(e.g. workflow analysis)

Data Science

Software Engineering

Tuple Health's data analysis and insights pipeline



Agenda

01 Applying human-machine collaboration in healthcare

02 Tuple Health overview

03 How we're building tools for human-machine collaboration

Our Approach

01

Clinical Need Finding & UX Testing.

Understanding the mental models and gaps in care that physicians and care teams both perceive and prioritize.

02

Workflow Analysis & Care Model Design.

Analyzing current workflows and care models in detail in order to identify strengths and improvement opportunities.

03

Clinically Informed Data Modeling.

Restructuring data to make it more clinically intuitive by drawing on need finding, workflow analysis and our own clinical acumen & data science capabilities.

04

Applying Clinical Edits and Heuristics.

Implementing heuristics and supporting algorithms to incorporate into workflow.

What causes hospitalizations?

A nephrologist's mental model:
What can I control?

01

Fluid Overload

- Dialysis related
- Other

02

Infections

- HD Vascular Access
- Other Related

03

Altered Mental Status

- Intra-dialysis
- Other

Span of control is the key driver

What causes hospitalizations?

Based on what we've learned from need finding and user experience research, we build off the mental models of several physicians and combine it with clinical expertise to make the data more clinically actionable.

01

Fluid Overload

- Dialysis related
- CKD
- CHF
- Liver disease

02

Infections

- HD Vascular Access
- Bacteremia
- Metastatic infection
- Organ system related (e.g. pneumonia)

03

Altered Mental Status

- Intra-dialysis
- Hypoglycemia
- Medication related
- Nosocomial

04

Volume Depletion

- Dialysis related
- Medication related

05

Electrolyte Disturbances

- Potassium
- Calcium
- Phosphate
- Sodium

Our Approach

01

Clinical Need Finding & UX Testing.

Understanding the mental models and gaps in care that physicians and care teams both perceive and prioritize.

02

Workflow Analysis & Care Model Design.

Analyzing current workflows and care models in detail in order to identify strengths and improvement opportunities.

03

Clinically Informed Data Modeling.

Restructuring data to make it more clinically intuitive by drawing on need finding, workflow analysis and our own clinical acumen & data science capabilities.

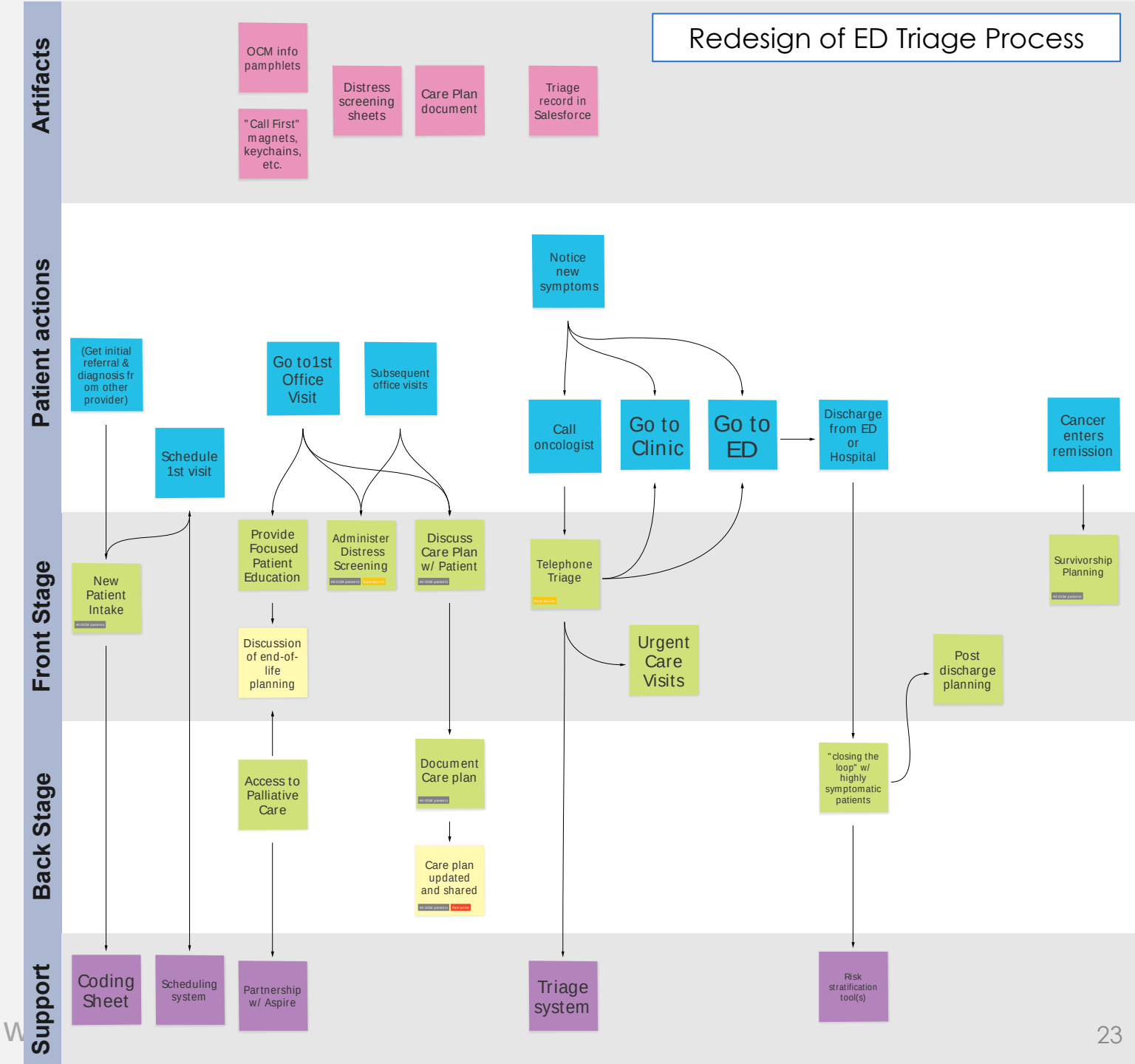
04

Applying Clinical Edits and Heuristics.

Implementing heuristics and supporting algorithms to incorporate into workflow.

Reducing Hospitalizations: making data actionable through workflow analysis

- We work closely with providers on **practice transformation**, from program development to redesigning workflows.
- This provides us with a **depth of understanding** of system's needs and perspectives.
- Particularly, we understand how leadership **makes decisions and trade offs** based on their strategic priorities.
- We work with providers to understand their data and deliver qualitative insights. A key component in this is **modeling risk & patient journeys**.



Our Approach

01

Clinical Need Finding & UX Testing.

Understanding the mental models and gaps in care that physicians and care teams both perceive and prioritize.

02

Workflow Analysis & Care Model Design.

Analyzing current workflows and care models in detail in order to identify strengths and improvement opportunities.

03

Clinically Informed Data Modeling.

Restructuring data to make it more clinically intuitive by drawing on need finding, workflow analysis and our own clinical acumen & data science capabilities.

04

Applying Clinical Edits and Heuristics.

Implementing heuristics and supporting algorithms to incorporate into workflow.

Tuple Health has been working on reorganizing claims data to optimize clinical utility for value based care.

Level 1	Level 2	Level 3	HCC	Name
HIV/AIDS			HCC1	HIV/AIDS
Sepsis			HCC2	Sepsis
Opportunistic Infections			HCC6	Opportunistic Infections
Cancer				Cancer
Cancer	Metastatic Cancer and Acute Leukemia		HCC8	Metastatic Cancer and Acute Leukemia
Cancer	Lung and Other Sever Cancers		HCC9	Lung and Other Sever Cancers
Cancer	Lymphoma and Other Cancers		HCC10	Lymphoma and Other Cancers
Cancer	Colorectal, Bladder, and Other Cancers		HCC11	Colorectal, Bladder, and Other Cancers
Cancer	Breast, Prostate, and Other Cancers and Tumors		HCC12	Breast, Prostate, and Other Cancers and Tumors
Diabetes				Diabetes
Diabetes	Diabetes with Acute Complications		HCC17	Diabetes with Acute Complications
Diabetes	Diabetes with Chronic Complications		HCC18	Diabetes with Chronic Complications
Diabetes	Diabetes without Complication		HCC19	Diabetes without Complication
Protein-Calorie Malnutrition			HCC21	Protein-Calorie Malnutrition
Morbid Obesity			HCC22	Morbid Obesity
Other Significant Endocrine and Metabolic Disorders			HCC23	Other Significant Endocrine and Metabolic Disorders
Liver Disease				Liver Disease
Liver Disease	End-Stage Liver Disease		HCC27	End-Stage Liver Disease
Liver Disease	Cirrhosis of Liver		HCC28	Cirrhosis of Liver
Liver Disease	Chronic Hepatitis		HCC29	Chronic Hepatitis
Gastrointestinal				Gastrointestinal
Gastrointestinal	Intestinal Obstruction/Perforation		HCC33	Intestinal Obstruction/Perforation
Gastrointestinal	Chronic Pancreatitis		HCC34	Chronic Pancreatitis
Gastrointestinal	Inflammatory Bowel Disease		HCC35	Inflammatory Bowel Disease
Bone/Joint/Muscle Infections/Necrosis			HCC39	Bone/Joint/Muscle Infections/Necrosis
Rheumatoid Arthritis and Inflammatory Connective Tissue Disease			HCC40	Rheumatoid Arthritis and Inflammatory Connective Tissue Diseas
Hematological				Hematological
Hematological	Severe Hematological Disorders		HCC46	Severe Hematological Disorders
Disorders of Immunity	Disorders of Immunity		HCC47	Disorders of Immunity
Hematological	Coagulation Defects and Other Specified Hematological Disorders		HCC48	Coagulation Defects and Other Specified Hematological Disorders
Mental Illness				Mental Illness
Mental Illness	Substance Abuse			Substance Abuse
Mental Illness	Substance Abuse	Drug/Alcohol Psychosis	HCC54	Drug/Alcohol Psychosis
Mental Illness	Substance Abuse	Drug/Alcohol Dependence	HCC55	Drug/Alcohol Dependence
Mental Illness	Psychiatric			Psychiatric
Mental Illness	Psychiatric	Schizophrenia	HCC57	Schizophrenia
Mental Illness	Psychiatric	Major Depressive, Bipolar, and Paranoic	HCC58	Major Depressive, Bipolar, and Paranoid Disorders
Neurologic				Neurologic
Neurologic	Neuromuscular			Neuromuscular
Neurologic	Neuromuscular	Quadriplegia	HCC70	Quadriplegia
Neurologic	Neuromuscular	Paraplegia	HCC71	Paraplegia
Neurologic	Neuromuscular	Spinal Cord Disorders/Injuries	HCC72	Spinal Cord Disorders/Injuries
Neurologic	Neuromuscular	Amyotrophic Lateral Sclerosis and Othe	HCC73	Amyotrophic Lateral Sclerosis and Other Motor Neuron Disease
Neurologic	Cerebral Palsy		HCC74	Cerebral Palsy
Neurologic	Neuromuscular	Myasthenia Gravis/Myoneural Disorders	HCC75	Myasthenia Gravis/Myoneural Disorders, Inflammatory and Toxic
Neurologic	Neuromuscular	Muscular Dystrophy	HCC76	Muscular Dystrophy
Neurologic	Multiple Sclerosis		HCC77	Multiple Sclerosis
Neurologic	Parkinson's and Huntington's Diseases		HCC78	Parkinson's and Huntington's Diseases
Neurologic	Seizure Disorders and Convulsions		HCC79	Seizure Disorders and Convulsions
Neurologic	Coma, Brain Compression/Anoxic Damage		HCC80	Coma, Brain Compression/Anoxic Damage
Cardio-Respiratory				Cardio-Respiratory

HCC classification of cancers is very limited

HCC8	Metastatic Cancer and Acute Leukemia
HCC9	Lung and Other Severe Cancers
HCC10	Lymphoma and Other Cancers
HCC11	Colorectal, Bladder, and Other Cancers
HCC12	Breast, Prostate, and Other Cancers and Tumors

Example: HCCs don't reflect clinical risk adequately

A-fib is a common complication of many OCM cancers leading to hospitalizations

HCC84	Cardio-Respiratory Failure and Shock
HCC85	Congestive Heart Failure
HCC86	Acute Myocardial Infarction
HCC87	Unstable Angina and Other Acute Ischemic Heart Disease
HCC88	Angina Pectoris
HC96	Specified Heart Arrhythmias

Disconnected from prevention or management:

- E.g. Atrial fib versus other arrhythmias and the risk for stroke
- Aggregating a spectrum of risk into a single category, e.g., CHF

HCC groupings of ICD codes obscure meaningful clinical information

icd	icddesc	hcc	r
I442	Atrioventricular block, complete	96	
I470	Re-entry ventricular arrhythmia	96	
I471	Supraventricular tachycardia	96	
I472	Ventricular tachycardia	96	
I479	Paroxysmal tachycardia, unspecified	96	
I480	Paroxysmal atrial fibrillation	96	
I481	Persistent atrial fibrillation	96	
I482	Chronic atrial fibrillation	96	
I483	Typical atrial flutter	96	
I484	Atypical atrial flutter	96	
I4891	Unspecified atrial fibrillation	96	
I4892	Unspecified atrial flutter	96	
I492	Junctional premature depolarization	96	
I495	Sick sinus syndrome	96	

Arrhythmias

icd	icddesc	hcc	r
A3681	Diphtheritic cardiomyopathy	85	
B3324	Viral cardiomyopathy	85	
I0981	Rheumatic heart failure	85	
I110	Hypertensive heart disease with heart failure	85	
I130	Hypertensive heart and chronic kidney disease with heart failur	85	
I132	Hypertensive heart and chronic kidney disease with heart failur	85	
I2601	Septic pulmonary embolism with acute cor pulmonale	85	
I2602	Saddle embolus of pulmonary artery with acute cor pulmonale	85	
I2609	Other pulmonary embolism with acute cor pulmonale	85	
I270	Primary pulmonary hypertension	85	
I271	Kyphoscoliotic heart disease	85	
I272	Other secondary pulmonary hypertension	85	
I2720	Pulmonary hypertension, unspecified	85	
I2721	Secondary pulmonary arterial hypertension	85	
I2722	Pulmonary hypertension due to left heart disease	85	
I2723	Pulmonary hypertension due to lung diseases and hypoxia	85	
I2724	Chronic thromboembolic pulmonary hypertension	85	
I2729	Other secondary pulmonary hypertension	85	
I2781	Cor pulmonale (chronic)	85	
I2783	Eisenmenger's syndrome	85	
I2789	Other specified pulmonary heart diseases	85	
I279	Pulmonary heart disease, unspecified	85	
I280	Arteriovenous fistula of pulmonary vessels	85	
I281	Aneurysm of pulmonary artery	85	
I288	Other diseases of pulmonary vessels	85	
I289	Disease of pulmonary vessels, unspecified	85	
I420	Dilated cardiomyopathy	85	
I421	Obstructive hypertrophic cardiomyopathy	85	
I422	Other hypertrophic cardiomyopathy	85	
I423	Endomyocardial (eosinophilic) disease	85	
I424	Endocardial fibroelastosis	85	
I425	Other restrictive cardiomyopathy	85	
I426	Alcoholic cardiomyopathy	85	
I427	Cardiomyopathy due to drug and external agent	85	
I428	Other cardiomyopathies	85	
I429	Cardiomyopathy, unspecified	85	
I43	Cardiomyopathy in diseases classified elsewhere	85	
I501	Left ventricular failure, unspecified	85	
I5020	Unspecified systolic (congestive) heart failure	85	
I5021	Acute systolic (congestive) heart failure	85	
I5022	Chronic systolic (congestive) heart failure	85	
I5023	Acute on chronic systolic (congestive) heart failure	85	
I5030	Unspecified diastolic (congestive) heart failure	85	
I5031	Acute diastolic (congestive) heart failure	85	
I5032	Chronic diastolic (congestive) heart failure	85	
I5033	Acute on chronic diastolic (congestive) heart failure	85	
I5040	Unspecified combined systolic (congestive) and diastolic (conge	85	
I5041	Acute combined systolic (congestive) and diastolic (congestive)	85	
I5042	Chronic combined systolic (congestive) and diastolic (congestiv	85	
I5043	Acute on chronic combined systolic (congestive) and diastolic (	85	
I50810	Right heart failure, unspecified	85	

CHF

We've initially mapped arrhythmias into six clinical categories that we will test with clinicians

icd	icddesc	hcc	r
I442	Atrioventricular block, complete	96	
I470	Re-entry ventricular arrhythmia	96	
I471	Supraventricular tachycardia	96	
I472	Ventricular tachycardia	96	
I479	Paroxysmal tachycardia, unspecified	96	
I480	Paroxysmal atrial fibrillation	96	
I481	Persistent atrial fibrillation	96	
I482	Chronic atrial fibrillation	96	
I483	Typical atrial flutter	96	
I484	Atypical atrial flutter	96	
I4891	Unspecified atrial fibrillation	96	
I4892	Unspecified atrial flutter	96	
I492	Junctional premature depolarization	96	
I495	Sick sinus syndrome	96	

Level 2	Input Code	Input Label
Atrial Fibrilation	I480	Paroxysmal atrial fibrilation
	I481	Persistent atrial fibrilation
	I482	Chronic atrial fibrilation
	I4891	Unspecified atrial fibrilation
Atrial Flutter	I483	Typical atrial flutter
	I484	Atypical atrial flutter
	I4892	Unspecified atrial flutter
Other SVT	I471	Supraventricular tachycardia
	I479	Paroxysmal tachycardia, unspecified
Ventricular Arrhythmia	I470	Re-entry ventricular arrhythmia
	I472	Ventricular tachycardia
Bradyarrhythmia / Heart Block	I442	Atrioventricular block, complete
	I495	Sick sinus syndrome
Premature Complexes / Contractions	I492	Junctional premature depolarization
	I491	Atrial premature depolarization
	I493	Ventricular premature depolarization

Our Approach

01

Clinical Need Finding & UX Testing.

Understanding the mental models and gaps in care that physicians and care teams both perceive and prioritize.

02

Workflow Analysis & Care Model Design.

Analyzing current workflows and care models in detail in order to identify strengths and improvement opportunities.

03

Clinically Informed Data Modeling.

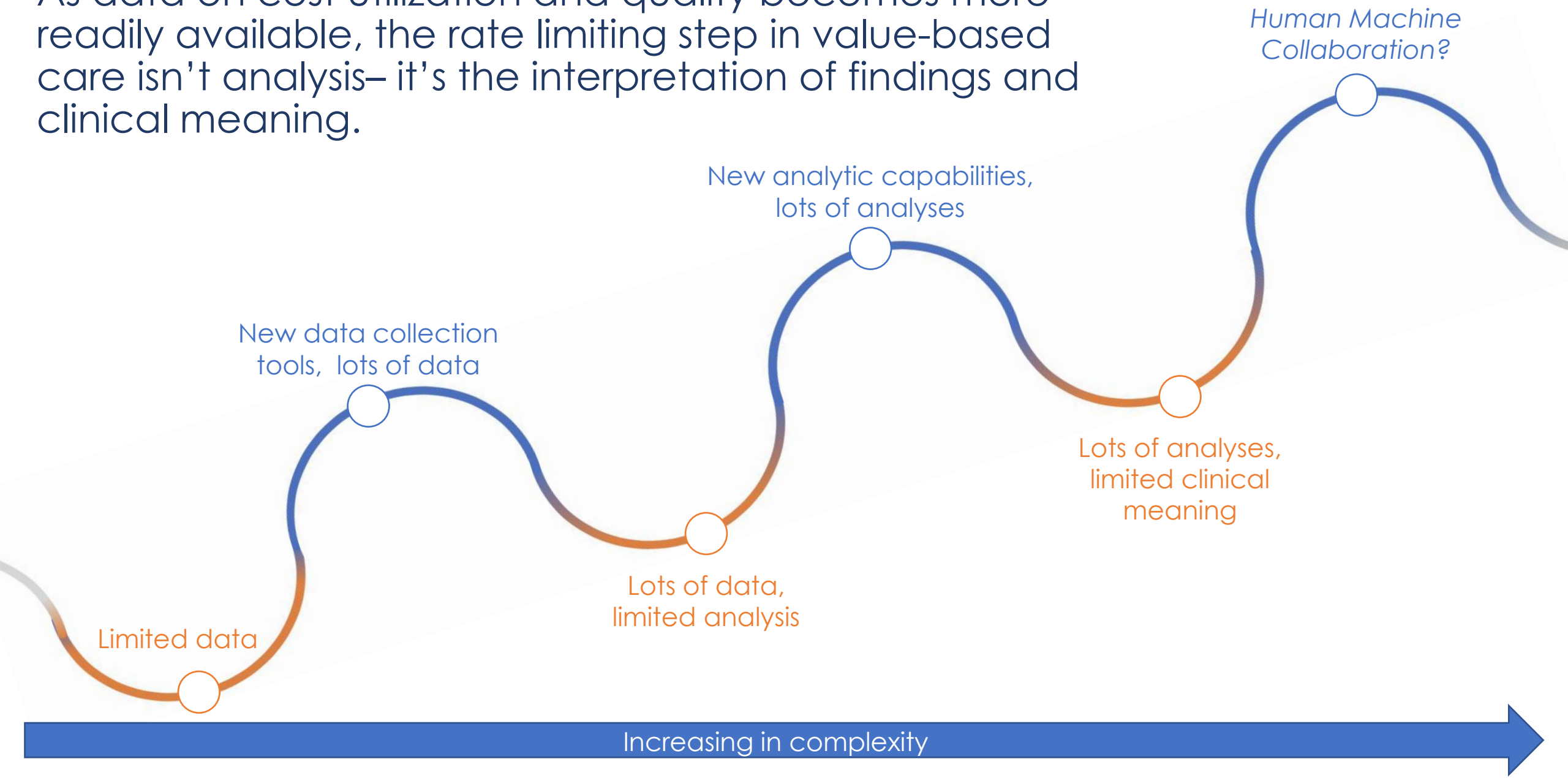
Restructuring data to make it more clinically intuitive by drawing on need finding, workflow analysis and our own clinical acumen & data science capabilities.

04

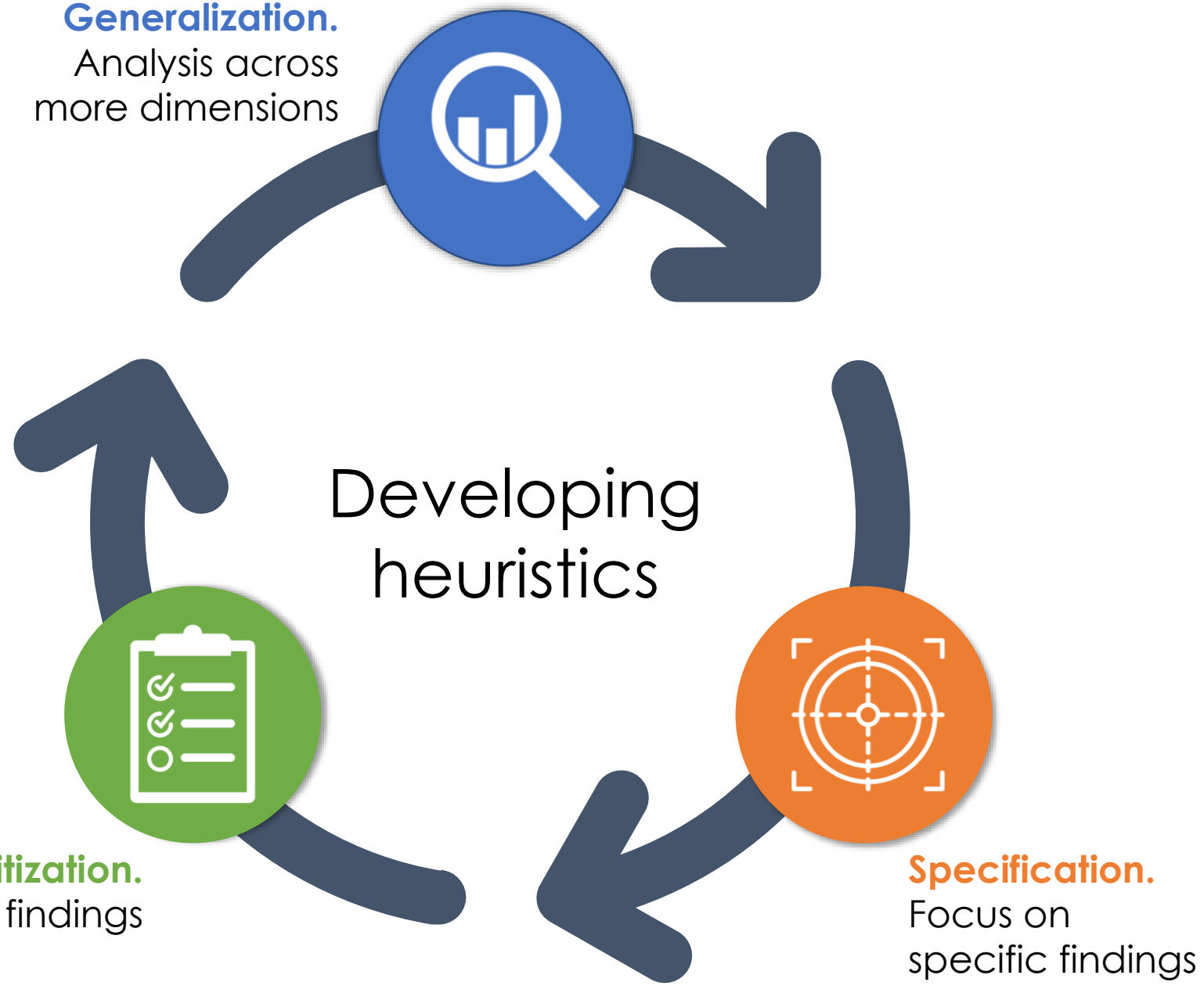
Applying Clinical Edits and Heuristics.

Implementing heuristics and supporting algorithms to incorporate into workflow.

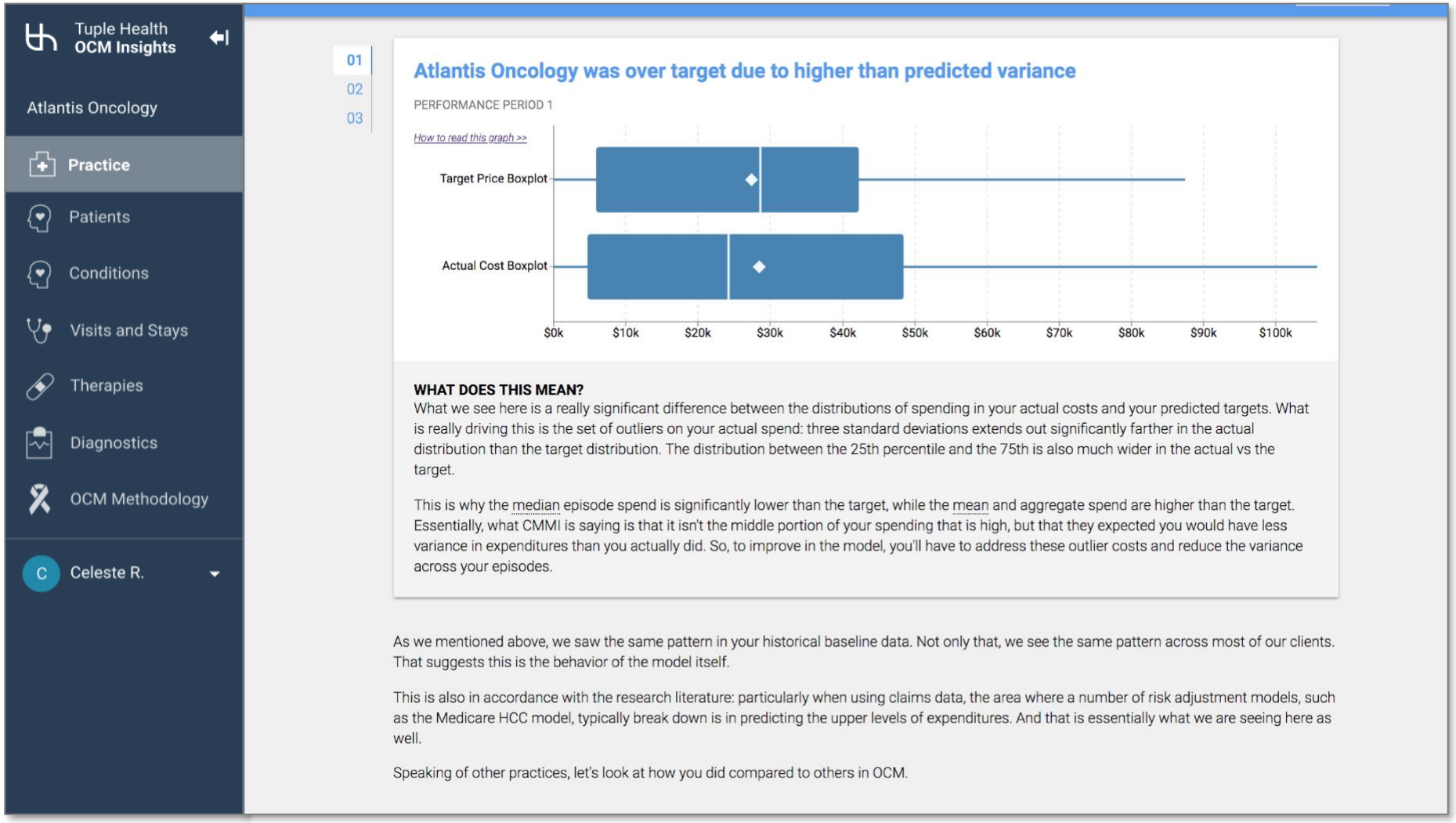
As data on cost utilization and quality becomes more readily available, the rate limiting step in value-based care isn't analysis– it's the interpretation of findings and clinical meaning.



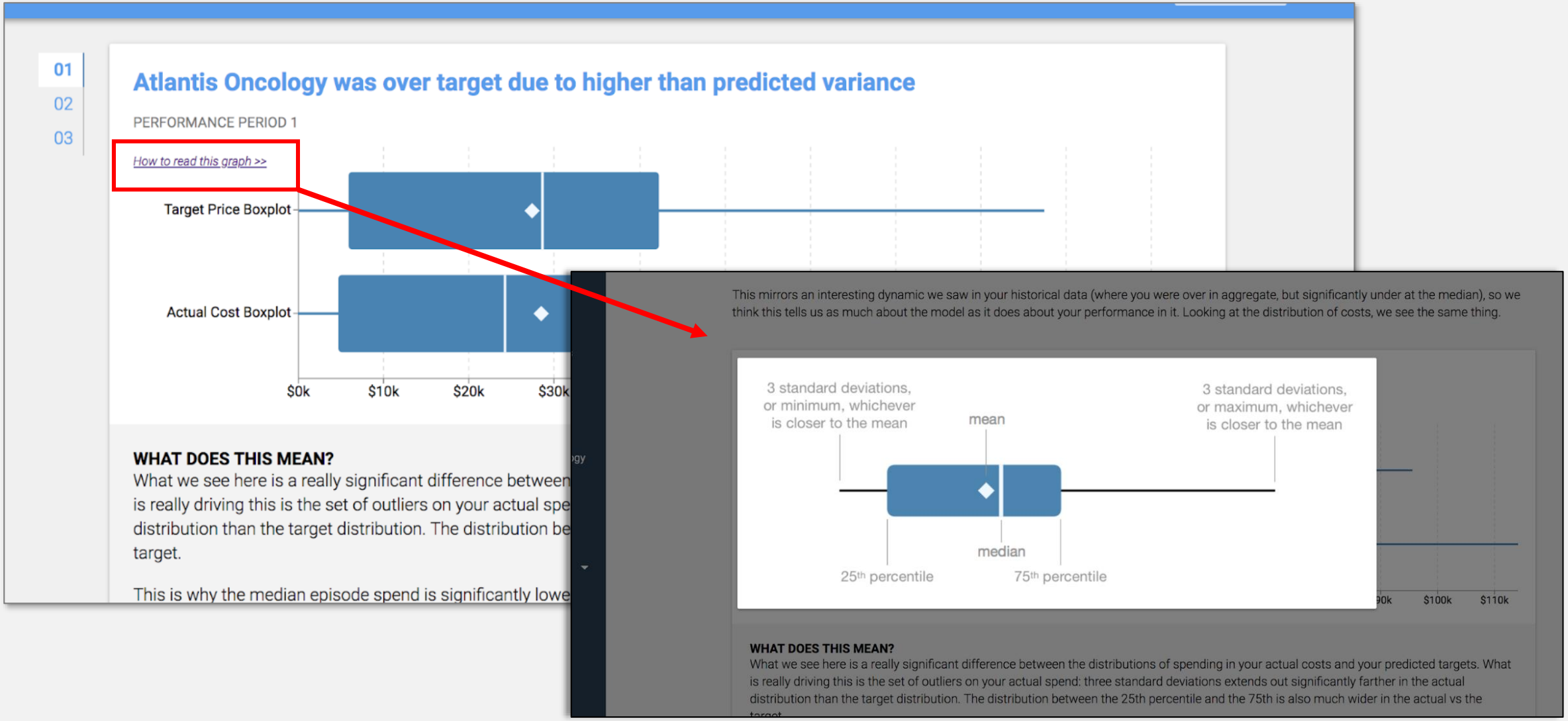
Because healthcare is human-centered, there are limits on automation. It is a continuous process of iteration balancing automation and human input.



Interpretation of the data is integrated into the product. We base this on a library of clinical edits and algorithms we've developed to facilitate scale.



From novice to expert, our product provides appropriate support for understanding analyses



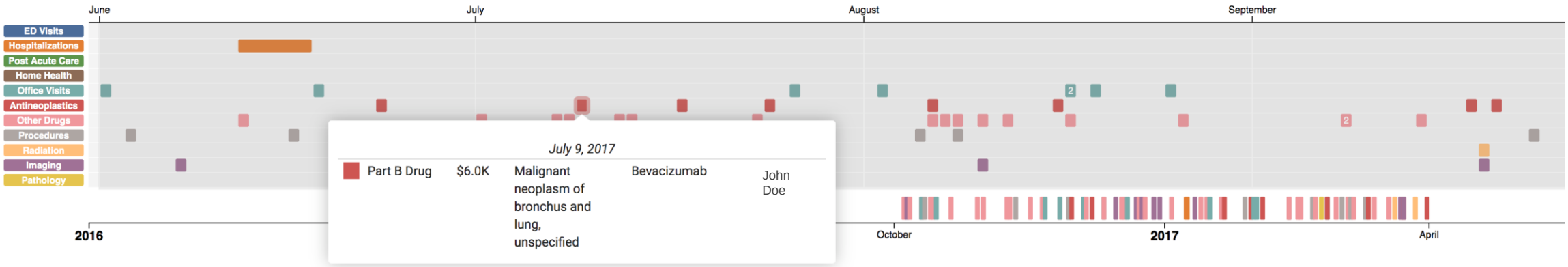
Reorganizing data to drive quality improvement and facilitate learning and interpretation.

Physician Engagement: Performance improvement to initiate ownership at the front lines

☆ **Ursela Hernandez** **Female | Date of birth 6/26/1944 | HICN 56006621**

OCM Attributed Cancer: Lung Cancer
OCM Attributed Clinician: John Doe

Add a private note about this patient...



Search

Procedure	Wed, Jun 28	$39	Neoplasm of uncertain behavior of skin	Shave skin lesion 1.1-2.0 cm	John Doe
				July 2017	
Part D Drug	Sat, Jul 01	$19		Atorvastatin	
Part D Drug	Fri, Jul 07	$2		Omeprazole	
Part D Drug	Sat, Jul 08	$2		Valsartan	
Part B Drug	Sun, Jul 09	$6.0K	Malignant neoplasm of bronchus and lung, unspecified	Bevacizumab	John Doe
Procedure	Tue, Jul 11	$31	Neoplasm of uncertain behavior of skin	Shave skin lesion 0.5 cm/<	John Doe
Radiation	Tue, Jul 11	$17	Malignant neoplasm of middle lobe, bronchus or lung	Stereoscopic x-ray guidance	Jane Smith
Part D Drug	Wed, Jul 12	$590			
Part D Drug	Thu, Jul 13	$2		Zolpidem	
Radiation	Sun, Jul 16	$130	Malignant neoplasm of middle lobe, bronchus or lung	Special radiation dosimetry	Jane Smith

Using algorithms to streamline and optimize manual, yet critical, processes:
Monthly Enhanced Oncology Services (MEOS) Payments in an episode-based oncology care model

Managing risk exposure: Automating attribution and closing gaps in PMPM payments, creating a 4-5x ROI and reducing processing costs (~40k claims managed)

Analyzed claims data to understand what was causing error rates

01

Conducted workflow analysis with billing, RCM, and care team members

02

Presented findings to practice leadership and board members

03

Developed a suite of algorithms to improve attribution accuracy and close gaps in PMPM payments

04

Implemented technology to manage gaps in PMPM claims & aligned with RCM vendor to streamline operations

05

Thank You!

basitchaudhry@tuplehealth.com