Building Data and Knowledge Management Systems Across the Cancer Control System

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Disclosures:

none relevant to today's discussion

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  - AbbVie
  - Agenus
  - Astellas
  - AstraZeneca
  - Baxalta
  - Bayer HealthCare
  - Breast Cancer Research Foundation
  - Bristol-Myers Squib
  - Celgene
  - Complion
  - Czarnowski
  - Derse, Inc.
  - Eisai
  - Exelixis
  - Genentech
  - GHI
  - Gilead Sciences
  - GSK Total
  - Incyte Corporation
  - Janssen
  - Jazz Pharma
  - Leap Therapeutics
  - Leidos
  - Lexicon Pharma
  - Lilly
  - Maltrex
  - Merck
  - Millennium
  - Novartis
  - Pfizer
  - Pharmacyclics
  - Robert Wood Johnson Foundation
  - Roche/Genentech
  - Sagerock Advisors
  - Sanofi
  - STO
  - Syntalogic
  - Taiho Oncology
  - Takeda
  - Tesaro
  - Teva

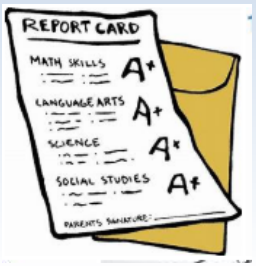
Data-Driven Improvements in Clinical Care

Clinical Research:

- Randomized Clinical Trials
- Pragmatic Trials
- Comparative Effectiveness Research
- Observational Research: Longitudinal Cohorts, Registries

Quality Improvement:

- Quality Metrics
- Clinical Pathways/Decision Support



Economic Factors:

- Health Care Resource Utilization

Current state of data accumulation:
Fragmented, Siloed, Expensive, Inefficient

Current State

Mrs. Smith, a 75 year old generally healthy but obese woman, presented to an emergency room with gastrointestinal bleeding

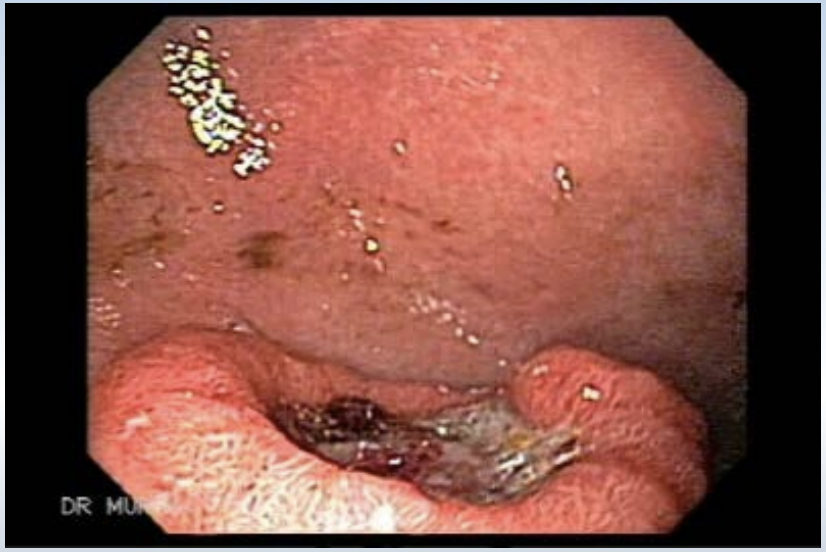
Upper endoscopy:

tumor at the junction of the esophagus and the stomach

Biopsy:

gastrointestinal stromal tumor

Current State



Hospital Name
Address

Surgical Pathology Report

Patient: Last Name, First Name
MRN: Medical Record Number
DOB: Date of Birth (Age: #)
Gender: M/F

Accession Number: Specimen Identification
Procedure: Date
Attending: Doctor's Name

Clinical History: Large Gastric Mass

Specimen: Gastric Mucosa

Diagnosis
Stomach, Partial Gastrectomy:
- Malignant Epithelioid Gastrointestinal Stromal Tumor
- Tumor Size 10 x 9 x 8 cm
- Cell Type: Epithelioid and Spindled
- High cellularity; present
- Mucosal Invasion: Focally present adjacent to ulceration
- Mucosal ulceration present
- Mitotic Count: 10/50 HPF
- Myxoid background: Focally present
- Foci of necrosis present
- CD117, vimentin, and CD34: uniformly positive

Gross Description
The specimen consists of an approximately 5 x 7 cm portion of gastric mucosa that is surrounded and underlying by a lobulated mass which is 10 x 9 x 8 cm. The central portion of the mass appears to have an approximately 1.5-cm ulcer. The mucosa away from the area of ulceration is partially removed from the underlying tumor. The underlying mass appears encapsulated and lobular. Gross sections show the lesion to consist of several different patterns. A single area has a gray to gray-tan pattern with an area of central necrosis showing a fairly uniform appearance whereas; other regions of the tumor are gray white- and somewhat lobular in appearance. Areas of yellow necrosis are scattered through the tumor. Representative portions submitted.

Microscopic Description
Sections through the neoplasm show it to be primarily a high cellular neoplasm. The cells are in part arranged in fascicles and clusters with enlarged elongate nuclei having relatively find nucleoli. In some areas, the fascicles have an interwoven appearance. Mitotic figure up to 10:50 HPF. A few areas show foci of necrosis with the cells appearing to be surrounded by somewhat myxoid stroma. Foci of displayed necrosis are present. The lesions appear circumscribed, although not specifically encapsulated. It focally involved the mucosa and shows full thickness ulceration. The tumor immediately beneath the mucosal area of ulceration has a nearly lobular somewhat spindled growth pattern. Some areas of the tumor have a slightly more rounded nuclei and somewhat epithelioid appearance. The cells appear to be arranged in groups and clusters. Some of the cells have cytoplasmic vacuoles. These areas also show a prominent mitotic activity. Some mitotic figured are abnormal and atypical. The tumor contains numerous relatively open vascular channels which appear to be part of the neoplasm. The tumor has a pseudo capsule and in some areas appear to be nearly covered.

Immunostains are strongly positive for CD117 (C-kit), CD34, and Vimentin, Smooth muscle actin, Desmin, Synaptophysin, S-100, and Ck8/18 are negative.

Comment
Immunostains were performed on the core biopsy and demonstrate that the tumor cells are positive for CD117. The findings are consistent with the above diagnosis.

data entry required:

demographics/insurance/contacts

complete medical history

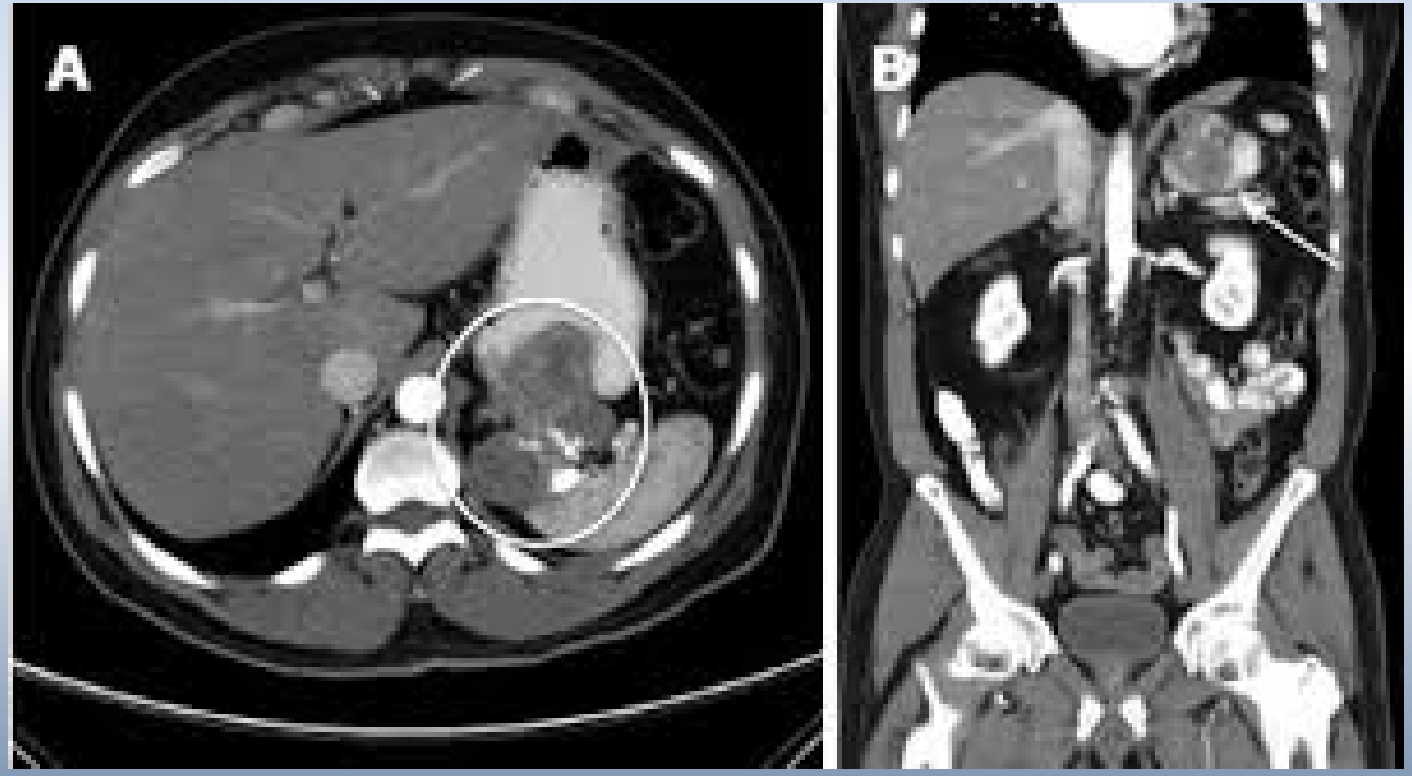
*CT Images not available

Current State

- Sent home, but worried because of no definite treatment plan
  - Next day: Emergency Room visit
    - She lives alone, her daughter misses several days of work to coordinate her care
      - Non-reimbursed medical expenses are increasing

Current State

- 2 days later, her CT scan arrives

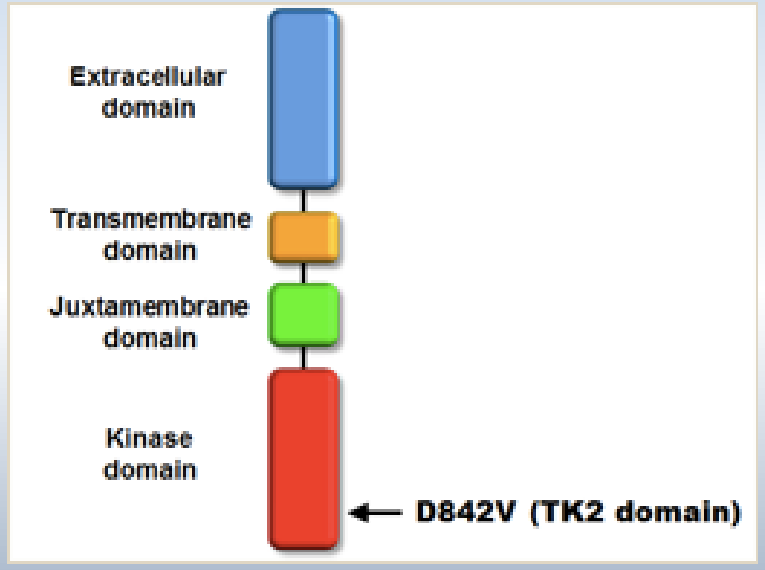


→ Medical Oncology referral

Current State

- Imatinib recommended; genotyping ordered

Result:



Conclusion: Imatinib is not effective

Current State

- Declines clinical trial participation
  - Subtotal gastrectomy performed
    - Lengthy post operative recovery
      - No adjuvant therapy, higher risk for disease recurrence

Current State

Outcome of 1000 Patients With Gastrointestinal Stromal Tumor (GIST) Treated by Surgery in the Pre and Post-imatinib Eras

Michael J. Cavnar, MD, Kenneth Seier, MsC,† Christina Curtin, BS,* Vinod P. Balachandran, MD,* Daniel G. Coit, MD,* Sam S. Yoon, MD,* Aimee M. Crago, MD, PhD,* Vivian E. Strong, MD,* William D. Tap, MD,‡¶ Mithat Gönen, PhD,† Cristina R. Antonescu, MD,§ Murray F. Brennan, MD,* Sam Singer, MD,* and Ronald P. DeMatteo, MD**

Annals of Surgery • Volume XX, Number XX, Month 2019

KIT exon 9	44 (7.6)
KIT exon 11 deletion	216 (37.1)
KIT exon 11 other	117 (20.1)
KIT exon 13	9 (1.5)
KIT exon 17	4 (0.7)
KIT multiple exons	48 (8.2)
PDGFRA D842V/I	23 (4)
PDGFRA other	27 (4.6)
NF1	5 (0.9)
SDH	3 (0.5)
Wild-type‖	86 (14.8)
Unknown	418 (N/A)

Our Future

- Mrs. Smith presents with a high risk gastrointestinal stromal tumor, complicated by gastrointestinal bleeding

- Well before her visit, her full EHR, including all images, is available to you formatted in a manner identical with the one that your team uses

Our Future

Compass™
Dr. Bran24 Michel09A

Mary Smith

Date of birth	Admin. sex	Location	Language
5 Apr 1967 (51)	Female	Boston, MA	English

ROID
12345432312

Treatment Options Nonmetastatic gastrointestinal stromal tumor, high risk

Outcomes for 12,345 patients with GIST were captured by CancerLinQ. more

> **Similar patients** 914 patients, age-matched >70*ref
criteria: *all*

> **Outcomes** overall survival rate and common s

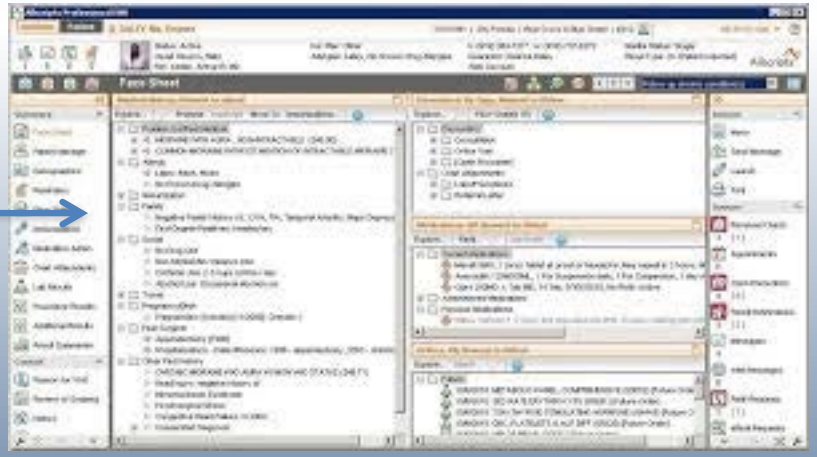
		Overall survival rates 1 yr	2 yr	5 yr
include only: add/remove				
surgery	(11)	95%	90%	77%
combine with: select treatments				
Imatinib mesylate	(70)	97% ▲2%	95% ▲5%	90% ▲13%

*tumor mutational testing may change recommendations, likelihood of this is 15% with gastric location of primary tumor; CLINICAL TRIALS MAY BE AVAILABLE

*recommend pre-operative functional assessment due to age, BMI

Our Future

- PLAN:
  - Genotyping, initiate pre-operative imatinib
  - Home-based fitness program in preparation for surgery in ~6 months



Our Future

Back home, Mrs. Smith is concerned that her bowel movements are a bit dark, and calls her granddaughter, who reports this to the web-based patient support site coordinated by your clinic

Our Future

- Tumor genomic characterization results show you that she is unlikely to respond to imatinib

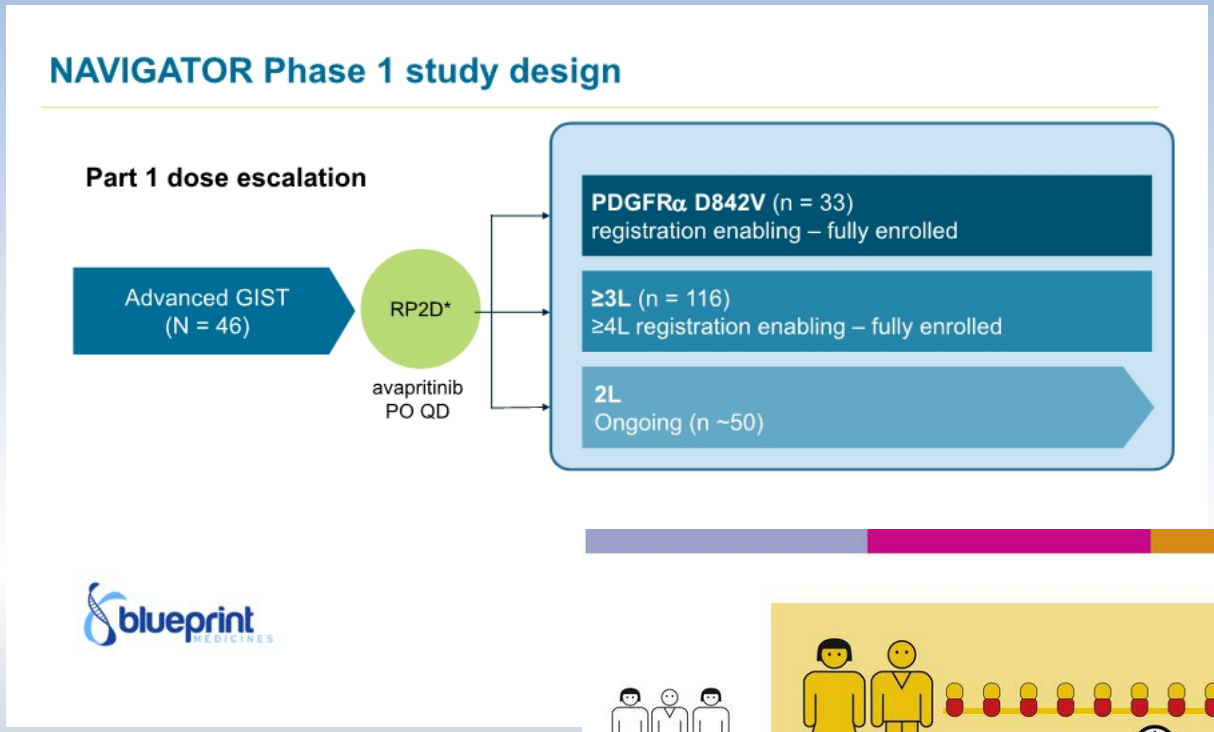
10.1200/JCO.2018.36.15_suppl.11533
Journal of Clinical Oncology 36, no. 15_suppl (May 20, 2018) 11533-11533.

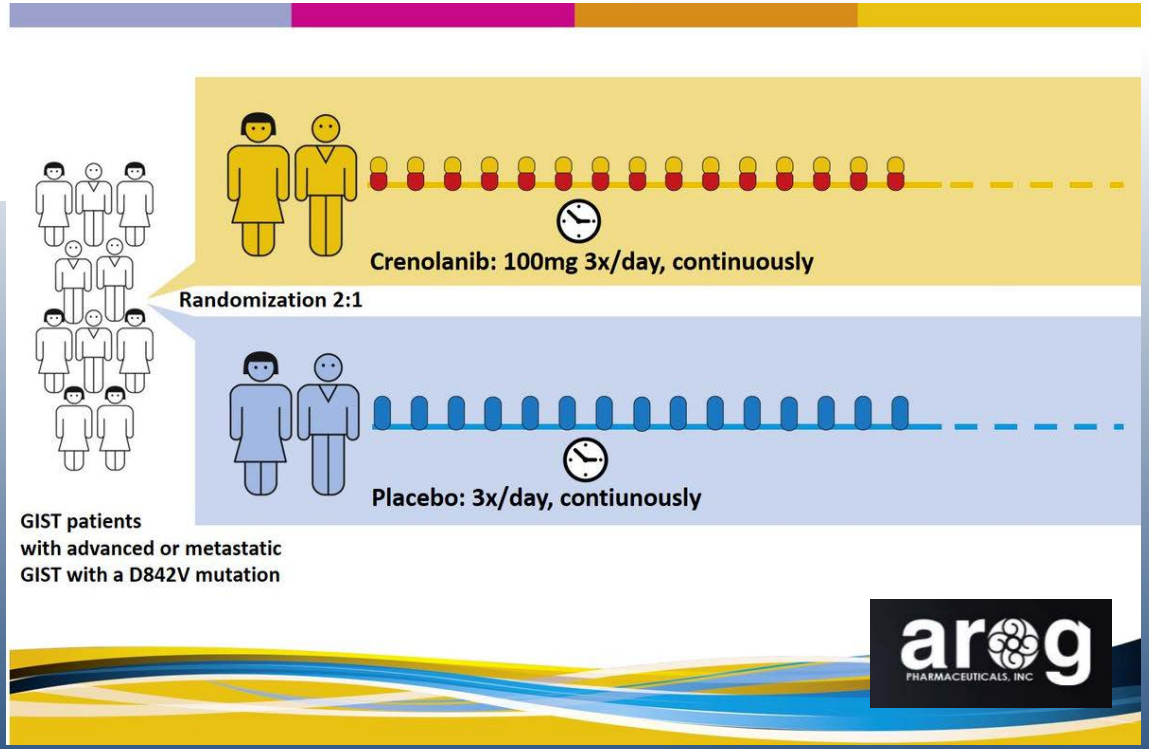
A retrospective natural history study of patients (pts) with PDGFRα D842V mutant advanced gastrointestinal stromal tumor (GIST) previously treated with a tyrosine kinase inhibitor (TKI).

Margaret von Mehren, Michael C. Heinrich, Hongliang Shi, Patrick McNamara, Khalid Kevin Mamlouk, Anthony Boral, ...

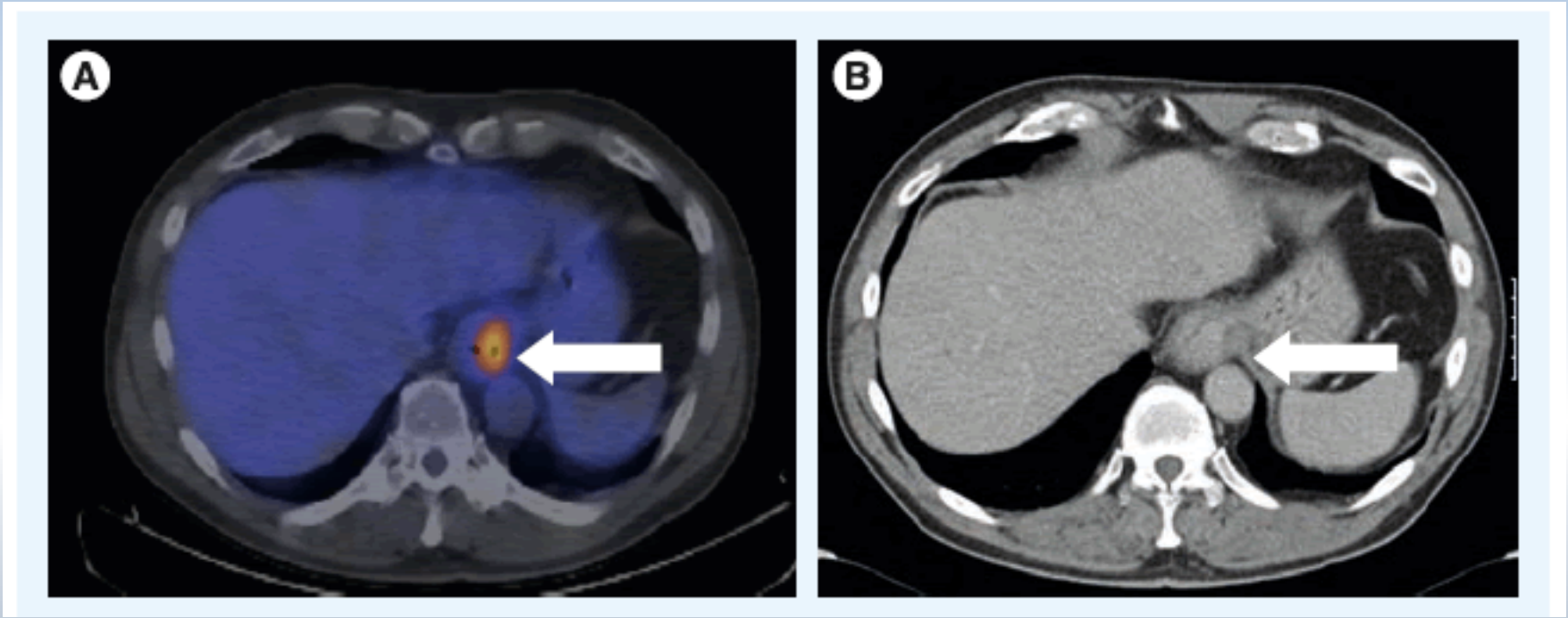
- Treatment change: surgery or treatment on a clinical trial

Our Future


NAVIGATOR Phase 1 study design
Part 1 dose escalation
Advanced GIST
(N = 46)
RP2D*
avapritinib
PO QD
PDGFRα D842V (n = 33)
registration enabling – fully enrolled
≥3L (n = 116)
≥4L registration enabling – fully enrolled
2L
Ongoing (n ~50)
blueprint
MEDICINES


Crenolanib: 100mg 3x/day, continuously
Randomization 2:1
Placebo: 3x/day, contiunously
GIST patients
with advanced or metastatic
GIST with a D842V mutation
arog
PHARMACEUTICALS, INC

Our Future



- Successful surgery, minimally invasive gastric resection
- Smooth post-operative recovery

Our Future

Five years later:

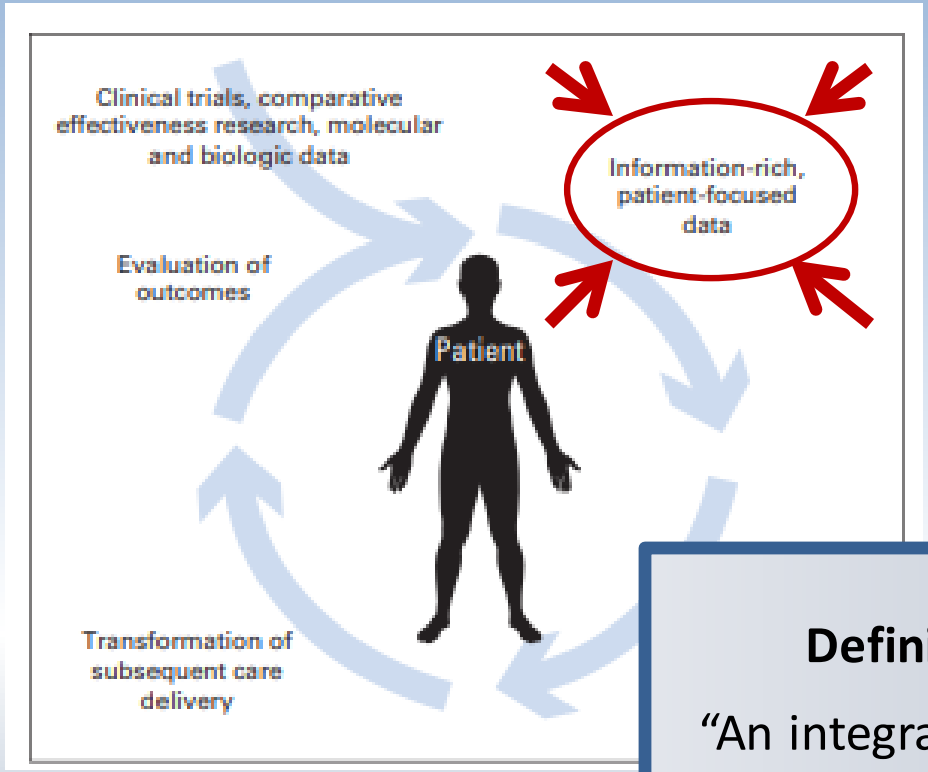
- International cohort: 90% of GIST patients,
  - 390 cases with a pD842V mutation

- Prospectively collected overall survival data from clinical trials and EHR-based longitudinal data

Our Future

- Clinical care is ***efficient***
- Unnecessary ***costs are reduced***
- ***Home-based*** evaluations and interventions are facilitated
- Patients and families are ***engaged and informed***
- ***Errors*** caused by poor communication ***are reduced***
- Research is ***facilitated***
- ***Learning is integrated*** into every-day practice

WHY IS THIS SO DIFFICULT TODAY?



Definition: Learning Health System

"An integrated health system which harnesses the power of data and analytics to learn from every patient and feed the knowledge of what works best back to clinicians, health professionals, patients and other stakeholders to create cycles of continuous improvement."

Friedman CP et al, 2010; Sci Trans Med 2:57

- **RECOMMENDATION A: A U.S. National Cancer Control Plan should principally ensure resource integration and operational coordination across the various components of the cancer control system and should actively do the following:**
- **Improve, where feasible, effective, and affordable, the availability of preventive, screening, diagnostic, and therapeutic interventions. Encourage timely palliative care, hospice care, survivorship services, and related social services according to the preferences and values of patients and their families.**
- **Leverage the advances in and apply "multi-omic" diagnostics to improve therapies and better understand their scientific, clinical, and economic**

Integrate the use of social, behavioral, and other information made possible by the convergence of communication, social media, cognitive, financial, and sensor technologies as well as electronic health records, cancer registries, and insurance claims to establish large-scale interoperable data sources.

- **Apply the tools of complex systems analyses for assessing the "value" of cancer control interventions, establishing robust policy and incentive assessments to guide the development and commercialization of products and services, developing new financing and payment mechanisms that alleviate overall cost burden, and aiding individual patients and their families in making informed decisions about cancer care.**
- **Minimize the waste and harm stemming from disparate clinical practices, interventions lacking evidence of effectiveness, and conflicting clinical practice guidelines.**
- **Track and monitor financial links, incentives, and disincentives throughout the processes and systems of cancer control and rigorously require conflict-of-interest disclosures across cancer care, research, and patient advocacy activities.**
- **Expand and support reproducibility strategies for developing reliable evidence in cancer control from biomedical, clinical, public health, and social science research.**
- **Discourage direct-to-consumer marketing and advertising of clinical products and services from companies, medical centers, intermediary firms, and other organizations by terminating the tax deductibility of these business expenses. Furthermore, tighten and enforce rules to particularly curb promotional tactics and strategies that are likely to mislead patients about the benefits of products and care services not based on strong evidence.**
- **Launch and expand public engagement, literacy, and outreach activities, starting with K–12 curriculums and through technology platforms, to broaden the understanding of cancer prevention as an integral component of a healthy life course.**

"Summary." National Academies of Sciences, Engineering, and Medicine. 2019. *Guiding Cancer Control: A Path to Transformation*. Washington, DC: The National Academies Press. doi: 10.17226/25438. ×


TOOLS AND ANALYTICS
DATA ACCESS
HIGH QUALITY COMPUTABLE DATA

STRUCTURED DATA ELEMENTS FROM CURRENT EHRs

GENERALLY AVAILABLE

- Diagnosis codes
- Encounter codes
- Infused medications
- Laboratory tests
- Smoking/Pain assessments
- Physical exam values

SOMETIMES AVAILABLE

- Staging (group and individual elements)
- Oral medications
- ER/PR/Her2 tests
- ECOG performance scores
- Hospice referral

GENERALLY NOT AVAILABLE

- Histology
- Genetic tests
- Treatment intent
- Surgery
- Radiation Therapy
- Imaging results
- **Disease status (progressing, stable, NED)**

ASCO CancerLinQ
Shaping The Future Of Cancer Care

Tobacco Use Assessment*

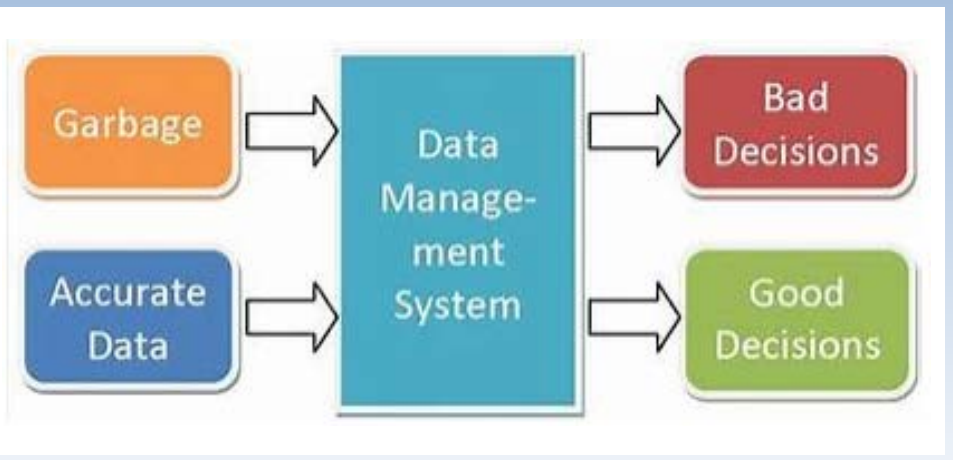
Value	Distinct Patients
Non-smoker	560,281
Never smoked tobacco	462,842
Ex-smoker	373,431
Current smoker	121,186
Unknown tobacco consumption	83,550
Smokes tobacco daily	81,250
Occasional tobacco smoker	22,607
Heavy smoker	5,898
Light tobacco smoker	3,478
Tobacco user	576
Current tobacco non-user	212
Chews tobacco	160
Passive smoker	140
Smokeless tobacco	96
Pipe smoker	23

*>15.5 million entries

Subset of **51** different representations

EMRs:

Allscrips	Epic
Aria	Mosaiq
Centricity	OncoEMR
CureMD	NextGen

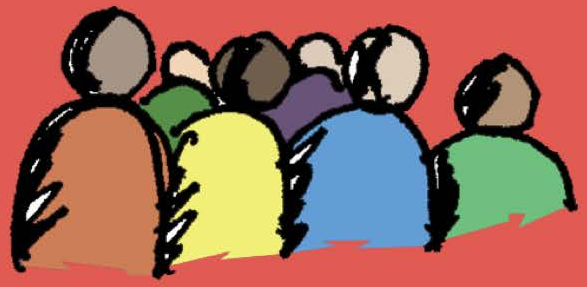


ASCO CANCER·LINQ
Learning Intelligence Network for Quality

1.6 million patient records received

We need better data!

Retrospective data curation using machine learning and national language processing is INSUFFICIENT and NOT SCALABLE



COLLABORATION ISN'T A 21ST CENTURY SKILL. IT'S A TIMELESS SKILL.

Collaboration was critical in the past and it will be critical in the future. Humans had to collaborate in the age of hunter-gathering and we'll need it in the age of artificial intelligence.

JOHN SPENCER

mCODE™

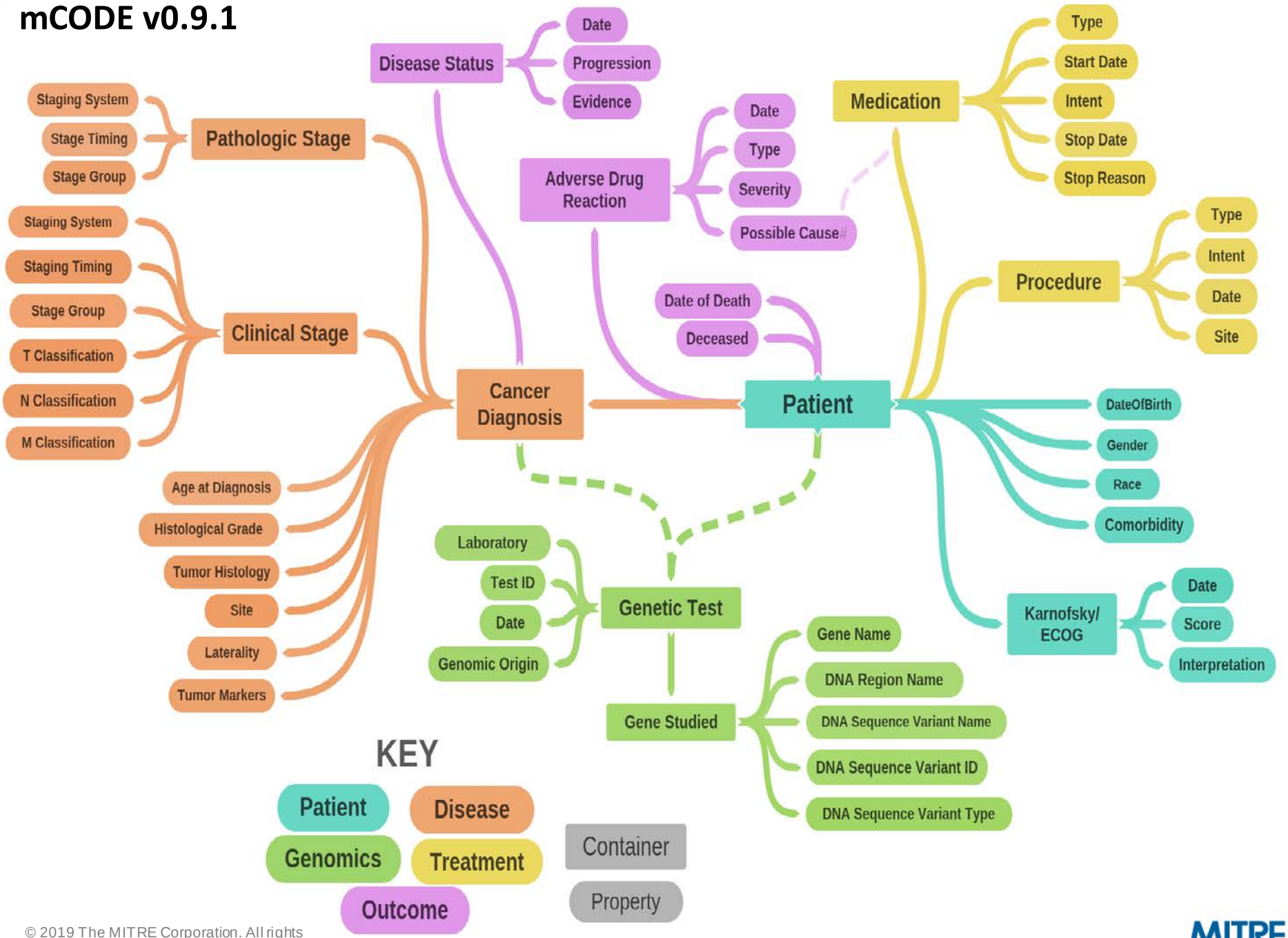
Purpose: To develop and maintain standard computable data formats, known as Minimal Common Oncology Data Elements (mCODE), to achieve data interoperability and enable progress in clinical care quality initiatives, clinical research, and healthcare policy development

MITRE FDA ASCO AMERICAN SOCIETY OF CLINICAL ONCOLOGY Alliance for Clinical Trials in Oncology FOUNDATION ASTRO TARGETING CANCER CARE

HL7 FHIR

mcodeinitiative.org

mCODE v0.9.1



MITRE

mCODE™

Will facilitate research

Integrating
Clinical trials
And
Real world
Endpoints
data

MITRE

ALLIANCE FOR CLINICAL TRIALS IN ONCOLOGY

FDA

NCI National Clinical Trials Network
a National Cancer Institute program

mCODE™

Will facilitate data sharing

A wide range of organizations will develop

mCODE™ -enabled

tools for data capture, analysis, and clinical application

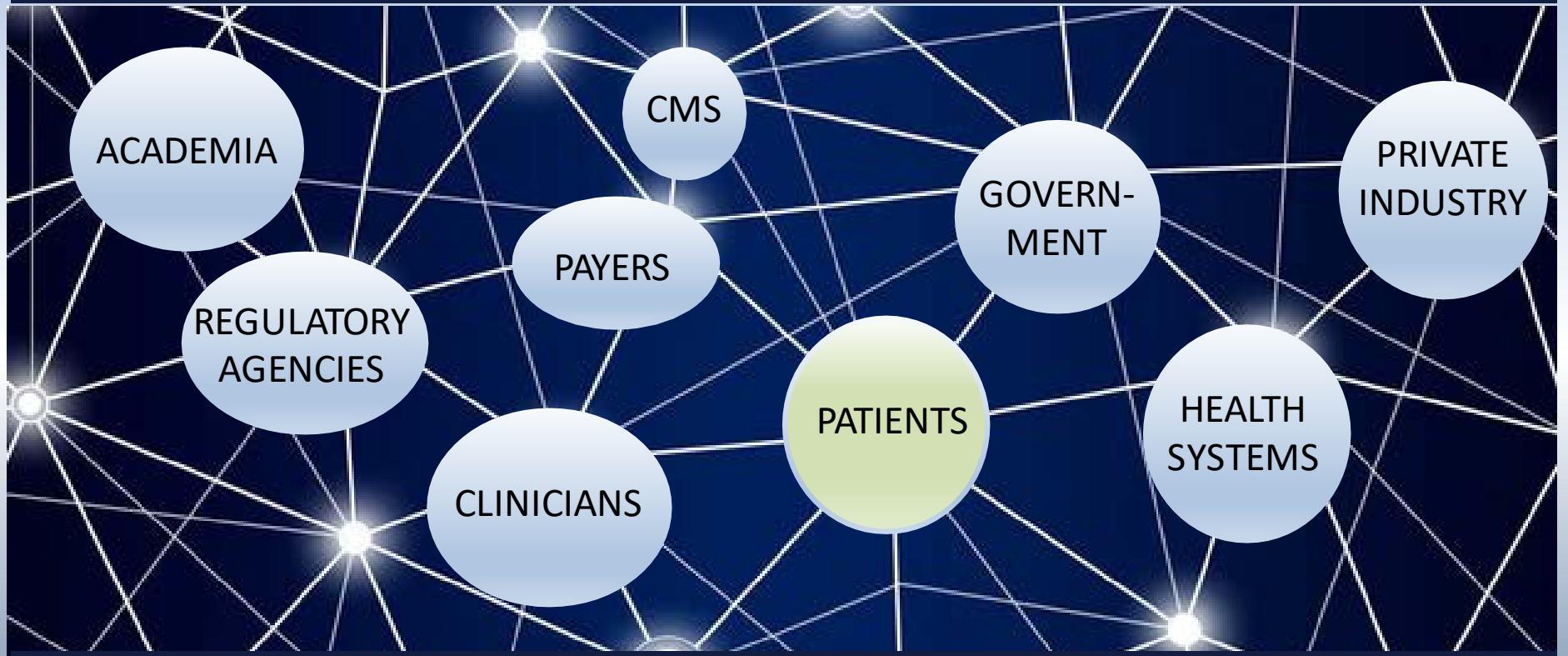
- Clinical pathways
- Clinical decision support
- Care coordination
- Clinical trials data management
- Clinical registries
- Outcomes research models
- Clinical practice quality initiatives
- Development and implementation of machine learning approaches

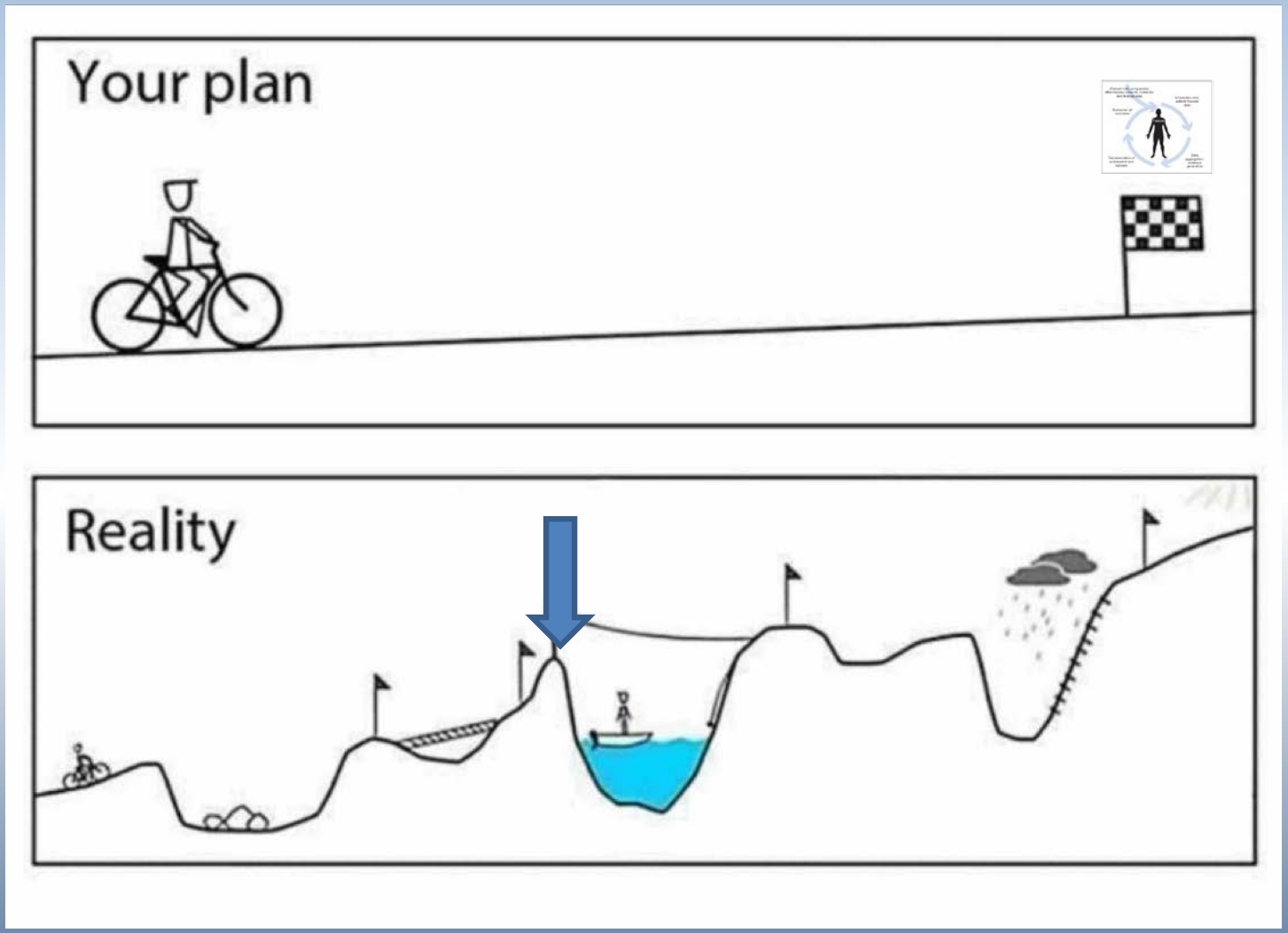
mCODE™

will facilitate patient engagement in healthcare

- Consent for research data use
- Patient reported outcomes
- Medical records home
- Patient education
- Care coordination
- Wellness programs
- Chronic disease management
- Rare disease care & research

Who benefits?




Your plan
Reality


ASCO
AMERICAN SOCIETY OF CLINICAL ONCOLOGY


MITRE


FDA


NIH
NATIONAL
CANCER
INSTITUTE


Perelman
School of Medicine
University of Pennsylvania


Intermountain
Healthcare


ASCO
CANCER·LINQ
Learning Intelligence Network for Quality


CIMI


HL7
INTERNATIONAL


RUSH UNIVERSITY
MEDICAL CENTER


DANA-FARBER
CANCER INSTITUTE


THE UNIVERSITY OF TEXAS
MD Anderson
Cancer Center


MAYO
CLINIC


CIIC


RUSH UNIVERSITY
MEDICAL CENTER


Washington
University in St. Louis
School of Medicine


ALLIANCE
FOR CLINICAL TRIALS IN ONCOLOGY


PARTNERS
HEALTHCARE


ASTRO
TARGETING CANCER CARE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