BMJ Clinical Intelligence

Delivering computable evidence at scale

BMJ Clinical Intelligence: the role of computable evidence in improving population health

Dr. Blackford Middleton
Yvonne Ridge
Dr. Chris Wroe

BMJ Clinical Intelligence: the role of computable evidence in improving population health

Meet our speakers

Dr. Blackford Middleton

Digital Knowledge Products Consultant, BMJ
Professor of Medicine, and of Biomedical Informatics (ret.)

Yvonne Ridge

Head of Product
BMJ

Dr. Chris Wroe

Head of Health Informatics
BMJ

BMJ Clinical Intelligence

Conflicts of interest

- Dr. Blackford Middleton, MD, MPH, MSc, FACP, FACMI, FHIMSS, FIAHSI
- Ms Yvonne Ridge, MSc
- Dr. Chris Wroe, MA MB BChir

- Work for or consulting to BMJ.
- Has no real or apparent conflicts of interest to report.

Agenda

BMJ Clinical Intelligence: the role of computable evidence in improving population health

- Evolution of knowledge representation for population health, clinical decision support and digital quality measures.
  - Breakout discussion
- Expressing computable evidence using a knowledge graph - an introduction to BMJ Clinical Intelligence
  - Breakout discussion
- Application of knowledge graph to bring digital quality measures into clinical workflow
  - Breakout discussion
- Conclusion and Q&A

Learning objectives

- Understand computable knowledge use for population health and digital quality measures.
- Understand the full spectrum of computable knowledge, its creation, and its use cases.
- Understand the challenges in applying computable knowledge in practice.

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What are the Big Ideas?

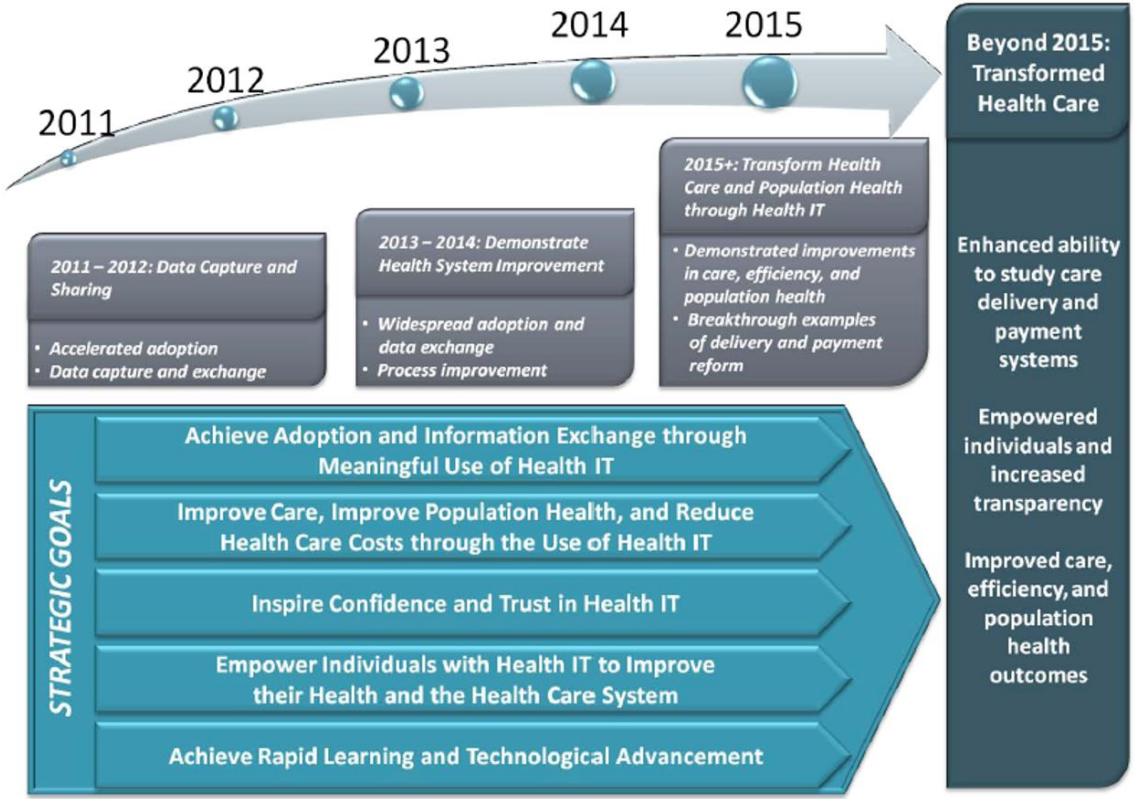
The practice of medicine is evolving in fundamental ways

- **Gather clinical data once** as a by-product of the clinical encounter (reduce physician burden), and all related community/public health data, social determinants of health
- **Reuse all data** for **all purposes**: Treatment, payment and operations (TPO), quality reporting, clinical decision support, operations improvement, public health, research/discovery (digital twins)
- **Patient at the center** – P4 Medicine (preventative, predictive, personalized, and participatory), collaborative and coordinated care across the continuum of care
- **Engage the patient** as a care collaborator – data acquisition, support self-care, shared-decision making
- **Employ cognitive aides** to augment clinical reasoning - by patient and by provider
- Create **computable knowledge** artifacts for all of the above – make them readily shareable and usable

Do all of this at scale – *standardize, streamline, and simplify*

American Plan: ARRA/HITECH

Feb 07, 2009



Toward Digital Health

"Dumb" Healthcare

- EMR
- Patient Portal
- EDW
- Revenue Cycle Management System
- Customer Relationship Management/ Call Center

"Smart" Healthcare

- Surveillance
- Discovery
- Prevention
- Prediction
- Anticipation
- Cognitive Aides
- Monitoring
- Feedback
- Learning

The Central Problem

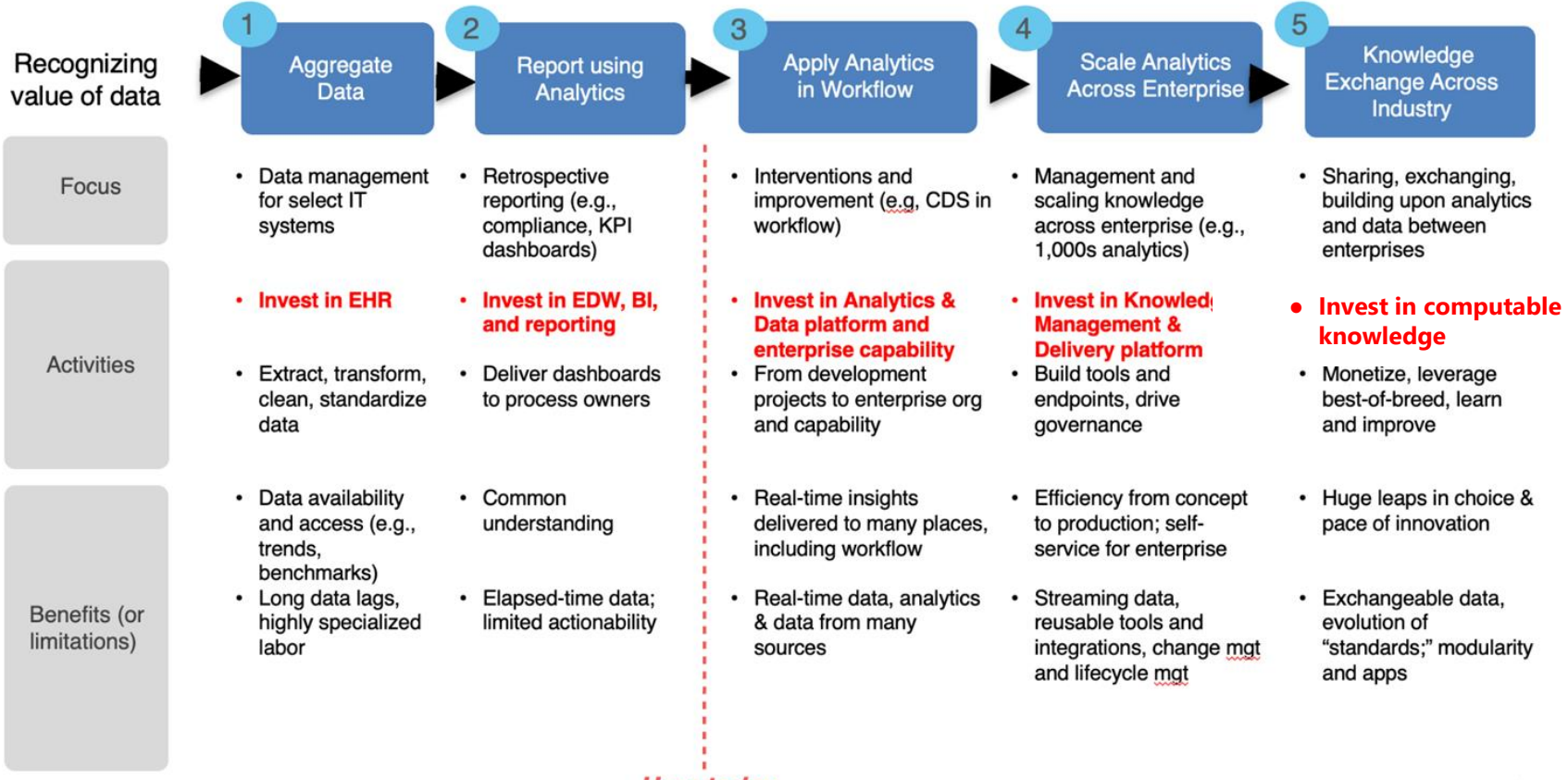
Why is it so hard to transform care with even the best health IT?

Lack of shareable computable knowledge – digital quality measures, clinical decision support, ePathways

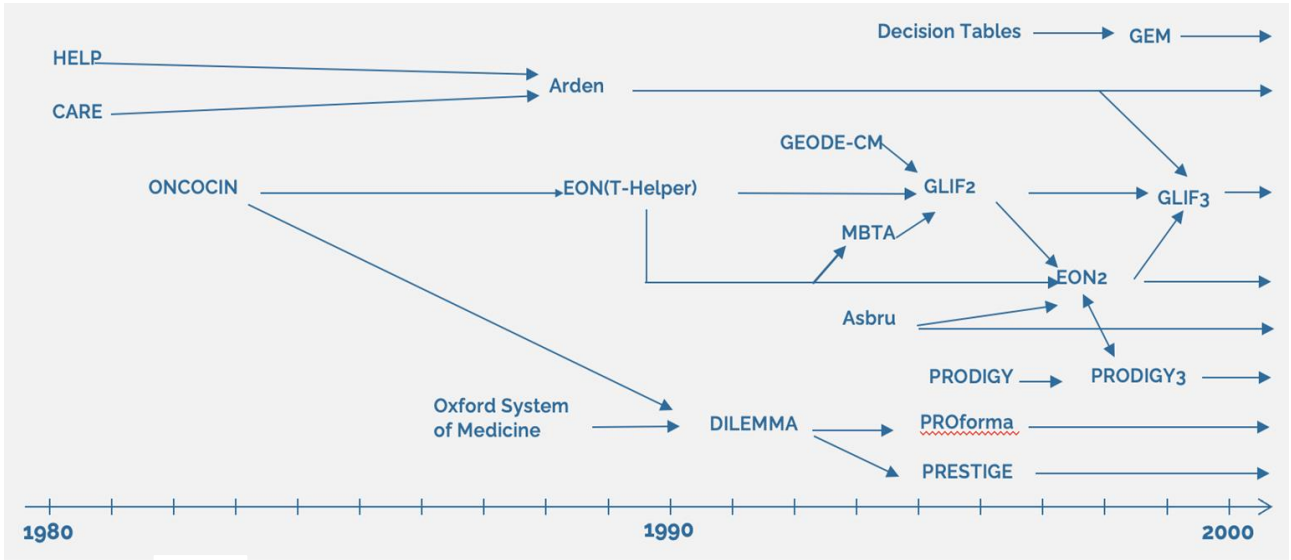
Simply put: the chasm which exists between published knowledge and clinical experience, and implemented knowledge in health IT, is too wide for the average clinician or healthcare delivery organization to manage.

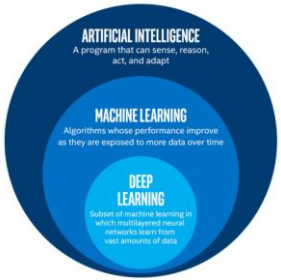
This must be achieved at scale for all to benefit - standardize, streamline, and simplify

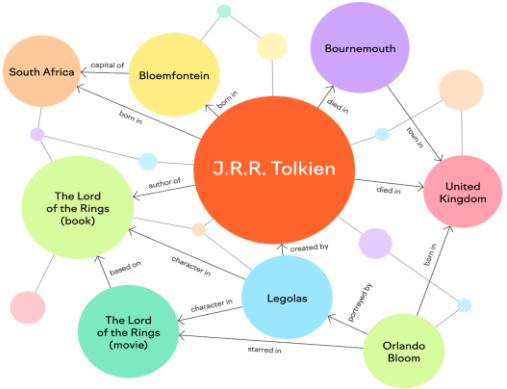
The Evolution of Analytics & Data



Knowledge translation and specification



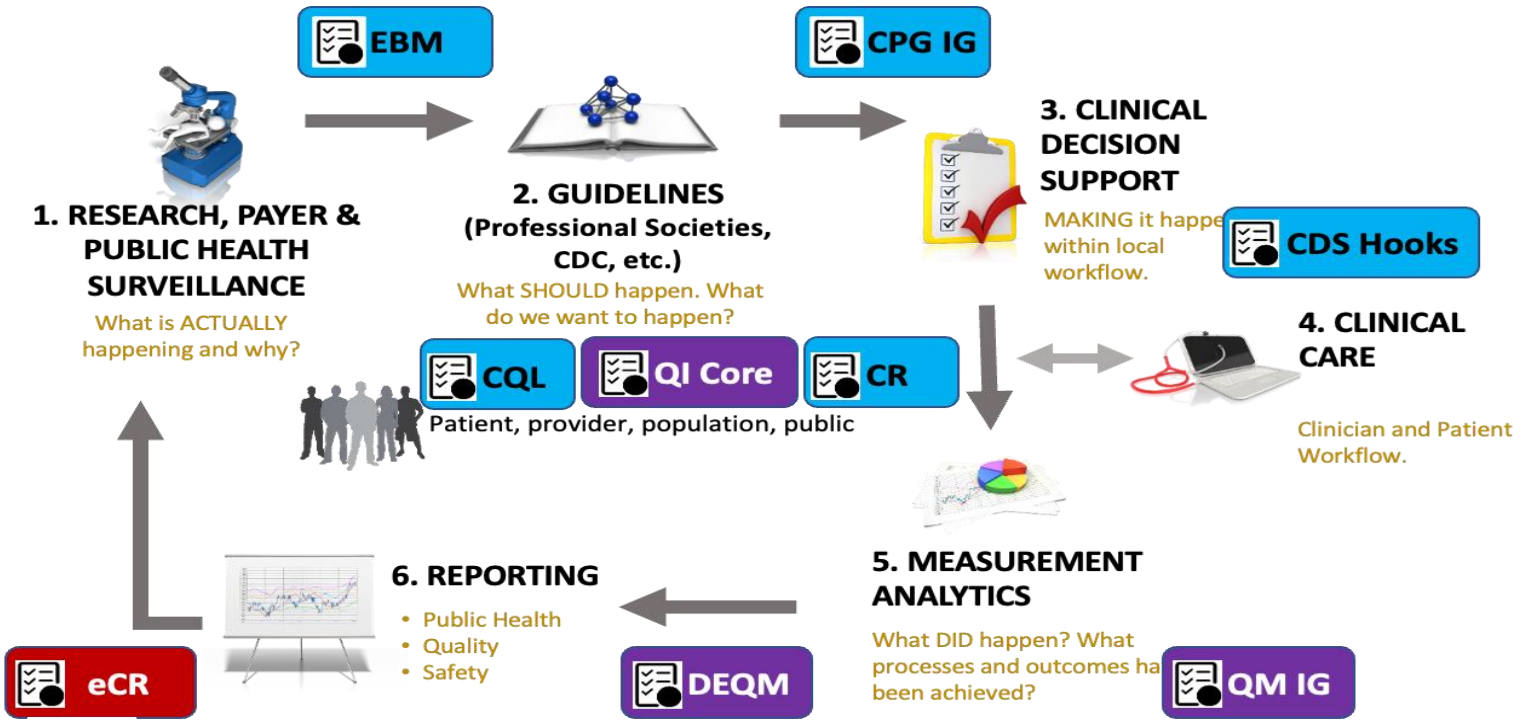




Elkin P, et al. MD Computing 17(6):39-44, 2000

Computable Clinical Practice Guidelines (CPGs), Digital Quality Measures, and e-Pathways

The Keystone an Interoperable Learning Health System

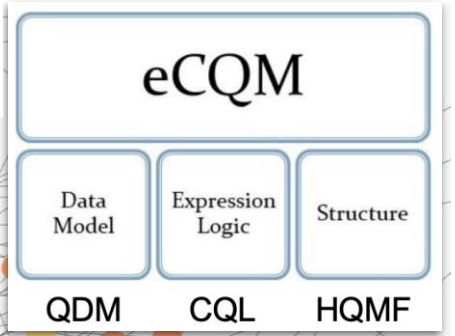


Source: https://build.fhir.org/ig/HL7/cqf-recommendations/

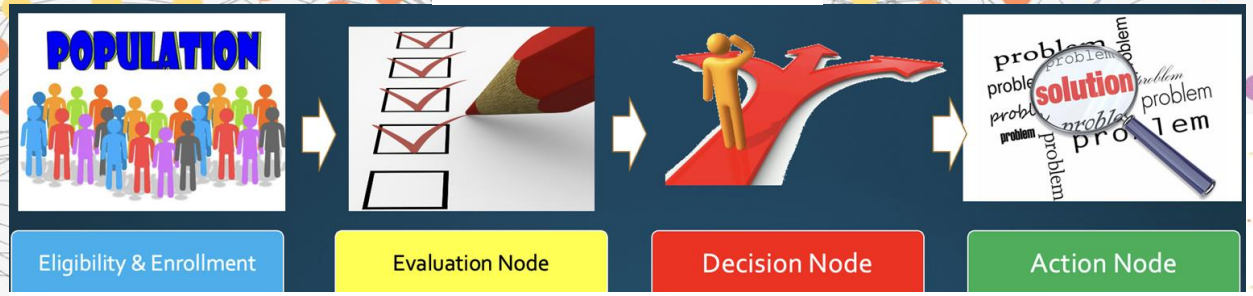
BMJ Clinical Intelligence Knowledge Graph for Population Health, digital QMs, and e-Pathways

POPULATION HEALTH

DIGITAL QUALITY MEASURES



CLINICAL E-PATHWAYS



Common Core Components:

- Common Interoperability Standards (FHIR)
- Common Data Model
- Common Measure Logic (CQL)
- Common Terminology Standards (SNOMED, RxNORM, LOINC, ICD (USCDI))

Do all of this at scale – *standardize, streamline, and simplify*

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Discussion: introduce yourself to the person beside you. Have a 5 min discussion on:

- How are you developing (digital) quality measures?
- What barriers do you face?
- Difficulty accessing data?
- Who is doing it?

Challenges in improving quality in healthcare where computable evidence can help

1. **Data collection and monitoring systems**
   - “It’s worth investing heavily in data from the outset”
   - Gather clinical data once

2. **Convince people that there’s a problem and the solution will work**
   - “Use hard data”
   - Where is care falling short of evidence based practice?

3. **Avoid unintended consequences**
   - Ensure the focus on the specific quality measure remains patient centric

4. **Securing sustainability**
   - From a one-off project to employing cognitive aids directly in the clinical workflow

Narrative review

Ten challenges in improving quality in healthcare: lessons from the Health Foundation's programme evaluations and relevant literature

Mary Dixon-Woods, Sarah McNicol, Graham Martin

ABSTRACT

INTRODUCTION

METHODS

Source: Dixon-Woods M, McNicol S, Martin G, BMJ Quality & Safety 2012;21:876-884.

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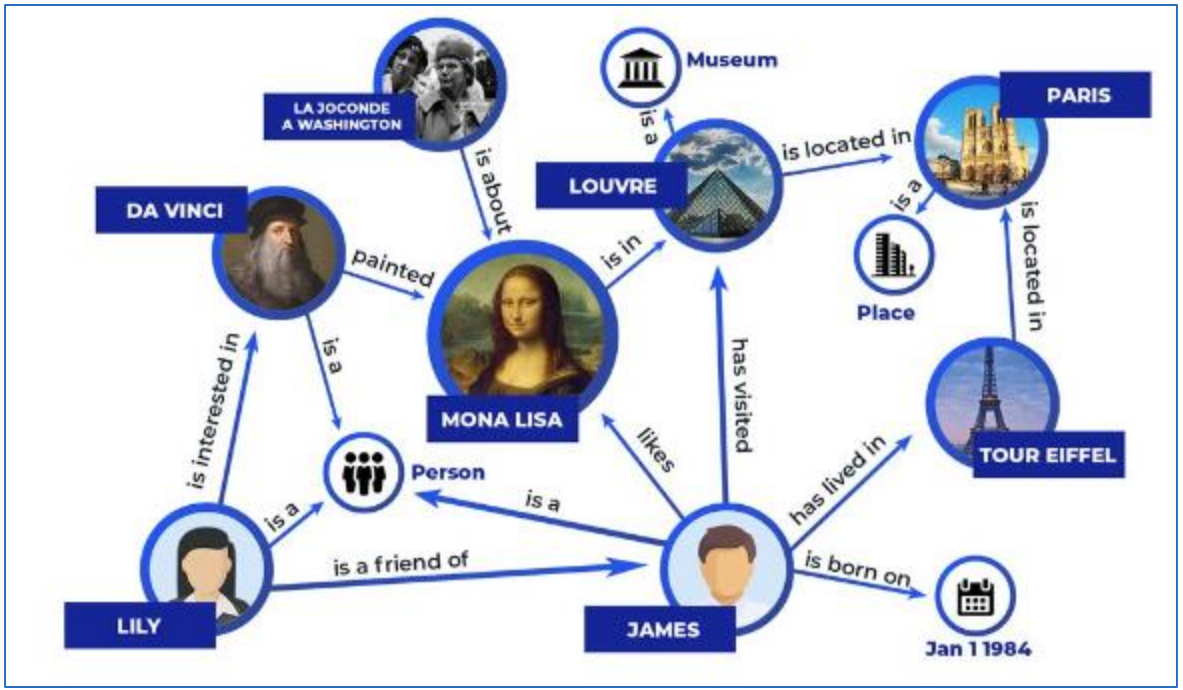
What is a knowledge graph?



- Named by Google in 2012
- Knowledge model in the form of interlinked concepts, entities and relationships
- Put data in context using linking and semantic tags to become structured data
- **The meaning of the data is encoded for programmatic use in an ontology which describes the types of entities and their characteristics**

What is BMJ Clinical Intelligence?

- Computable evidence in the form of a knowledge graph
- Rigorous editorial methodology to ensure continuously updated, top quality, evidence-based content
- Used by BMJ for our own products and our customers
  - Integrated into clinical systems and workflows
  - Underpin end-user clinical products
  - Evidence view alongside real-world data (eg: patient records, claims data)

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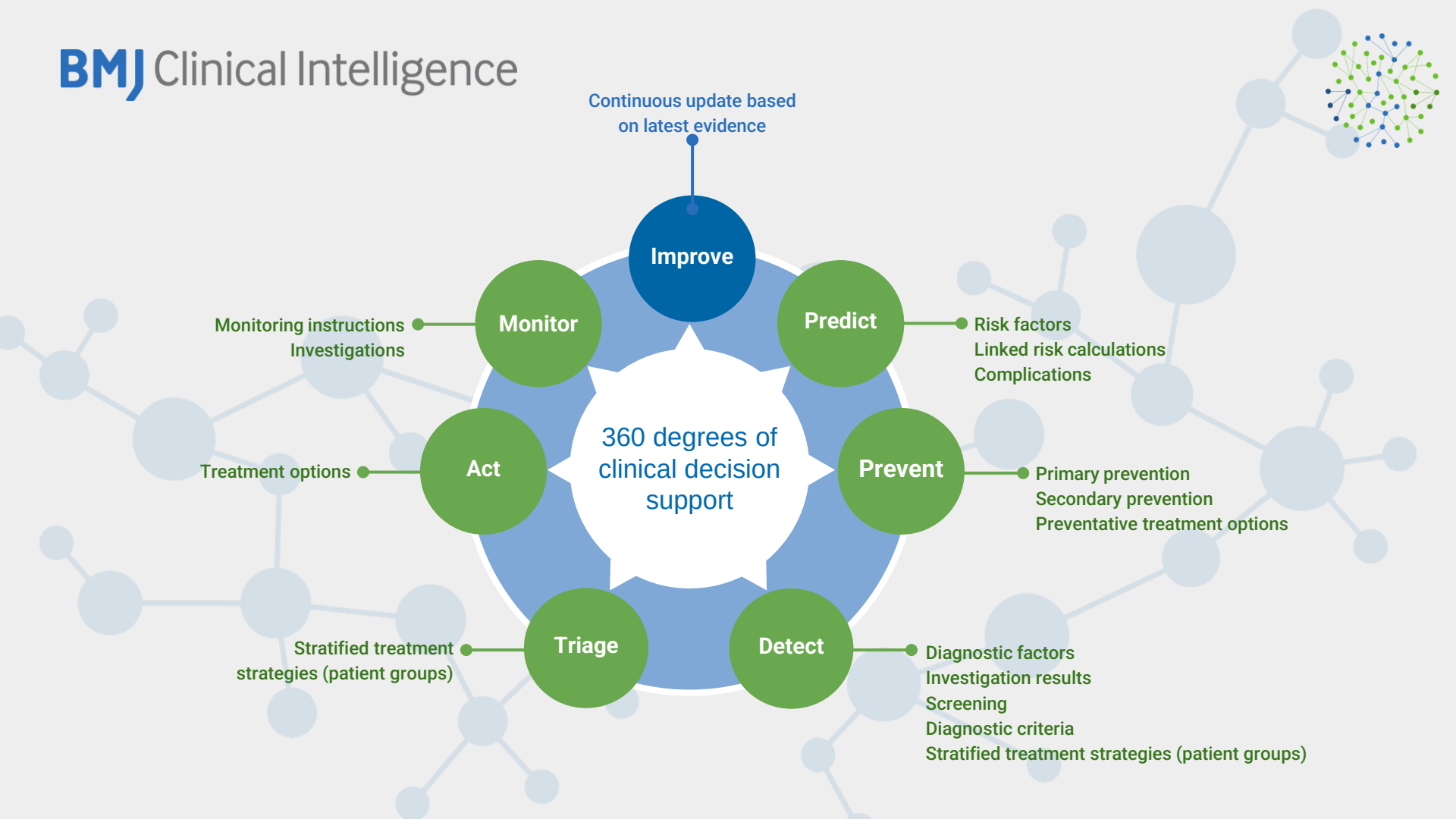


Robust evidence-based methodology to knowledge creation

1. Surveillance

- Current awareness
- Peer review
- Drug surveillance
- Literature review

FEEDBACK

Feedback button on every page of our end user products

700k global user base

2. Appraisal

- Contributor
- Section editor
- Drug editor

Decision

- Patient safety update
- Practice changing update
- Practice confirming update

Over **1000** topic updates per year

60+ US guideline producers

600+ US guidelines assessed in 2023

3. Update

- Editor
- Contributor
- Tech editor
- Drug editor

BMJ Knowledge Content Editor

Bespoke content management system

4. QA, approval, publication

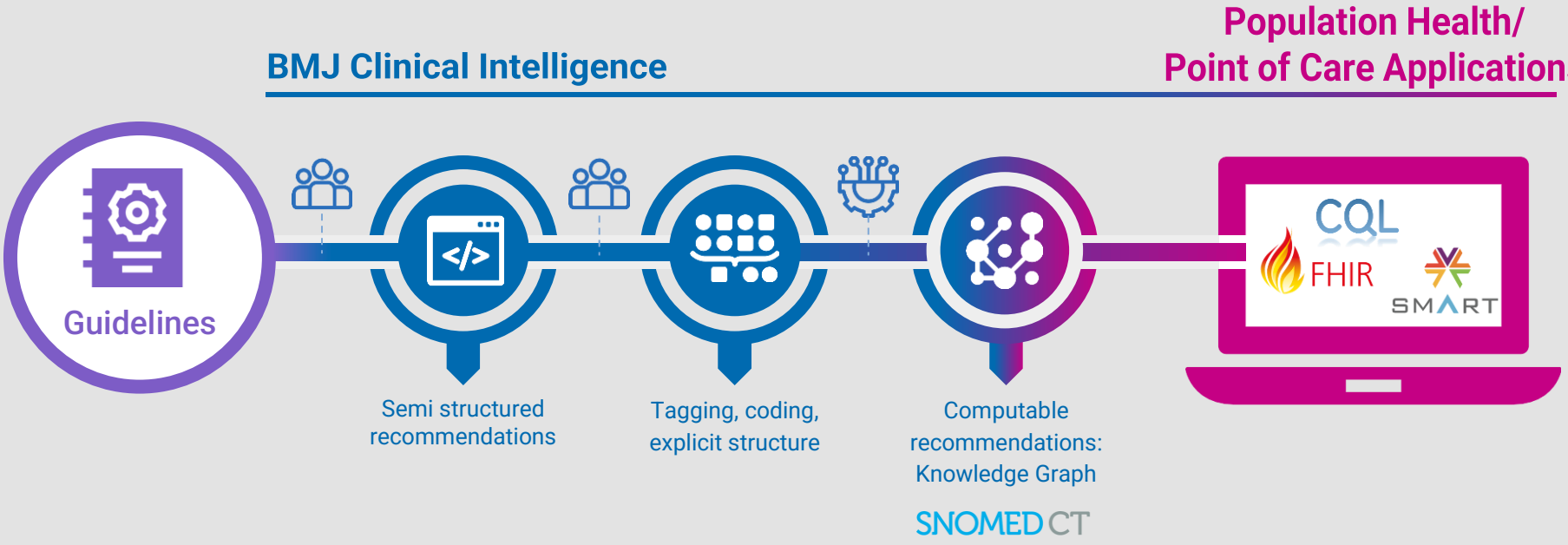
- Preview publication
- Lead editor
- Sector editor
- Drug editor
- Live publication

XML

Customer applications

BMJ Best Practice

Getting evidence into analysis and decision support



Use cases - where and when we can help

Where knowledge graphs help

Directing care where it is most needed - patient risk stratification

- Support step up/ step down care, care at home, remote monitoring

Intelligent chart summarization

- Simplify and streamline condition specific chart summary for the clinician

Reduce unwarranted variation in investigation, treatment, and monitoring

- Support next best clinical action to improve outcomes
- Reduce low value tests and procedures

Diagnostic error and diagnostic delay

When knowledge graphs help

Population health analytics

- Pivoting to value based care - *optimise care for a population*
- Support allocation of care resources to most in need of care

At the point of care for individuals

- Evidence derived data to suggest next best actions to the clinician

Supporting healthcare professionals in prior auth

- Stratify populations into positives, greys and negatives for clinical review.

AI deployment

- Evidence derived data for training, testing and monitoring AI models
- Heuristically supervised learning

Discussion: Introduce yourself to the person to your other side, or carry on discussing with the same person as before. Have a 5 min discussion on:

- What knowledge resources are you using today for digital measures?
- Are they rules based?
- Using you using Generative AI (eg: ChatGPT)?

Towards Technical Implementation of Dynamic Quality Improvement

- Data Collection and Monitoring - gather clinical data once
  - Maturing clinically focused standards for healthcare data and apps
- Convince people there is a problem and the solution will work
  - Use data and evidence based computable knowledge resources
- Avoid unintended consequences
  - Patient at the centre
  - Engage the patient
- Securing sustainability
  - Employ cognitive aids directly in the clinical workflow

Challenge 1

Data Collection and Monitoring - Gather clinical data once

The maturing Health IT landscape

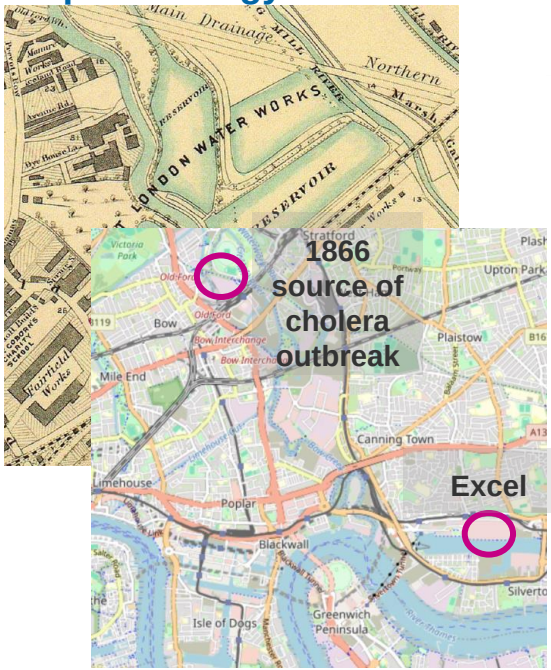
Data Foundation

HL7 FHIR data - 10 years

SNOMED-CT – 25 year maturity

ICD – 100 to 150 year history

Supporting Census and Epidemiology



Supporting Direct Care

HL7 Fast Healthcare Interoperability Resources

Level 4 Record-keeping and Data Exchange for the healthcare process

Clinical	Diagnostics	Medications	Workflow	Financial
Allergy, Problem, Procedure, CarePlan/Goal, ServiceRequest, Family History, RiskAssessment, etc.	Observation, Report, Specimen, ImagingStudy, Genomics, Specimen, ImagingStudy, etc.	Medication, Request, Dispense, Administration, Statement, Immunization, etc.	Introduction + Task, Appointment, Schedule, Referral, PlanDefinition, etc	Claim, Account, Invoice, ChargeItem, Coverage + Eligibility Request & Response, ExplanationOfBenefit, etc.

Level 5 Providing the ability to reason about the healthcare process

Clinical Reasoning	Medication Definition
Library, PlanDefinition & GuidanceResponse, Measure/MeasureReport, etc.	Medicinal, Packaged & Administrable product definitions, Regulated Authorization, etc.

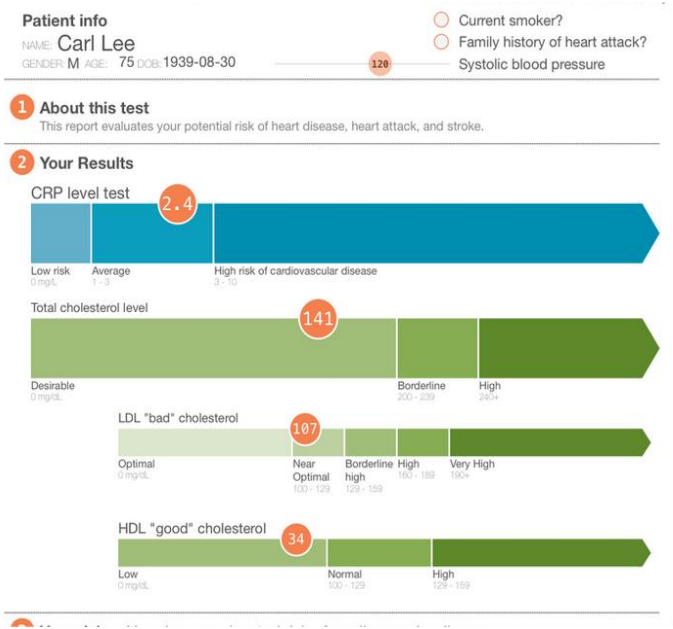
Point of Care Applications

FHIR Structured Data Capture

SMART on FHIR app store model 5 years

Electronic Patient Record 30 year maturity

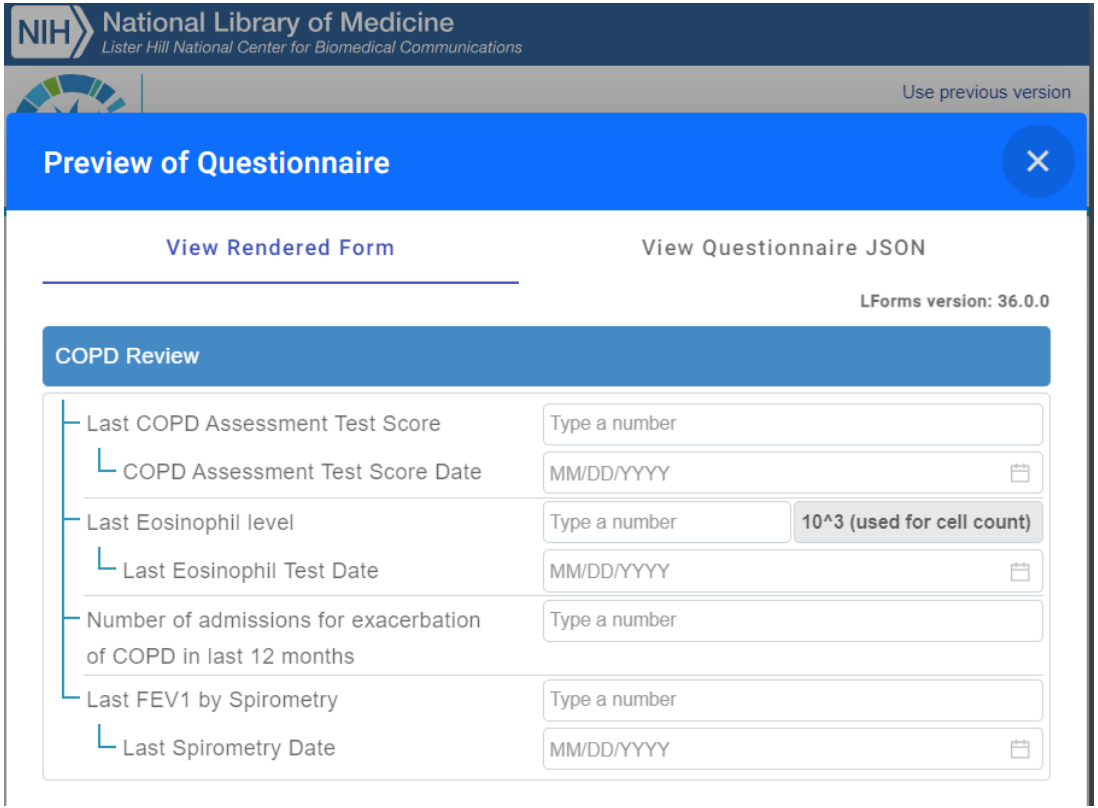
Supporting Patient Administration



Supporting the clinician

Example from Boston Children's Hospital Cardiac Risk Score App

Standards Based Data Capture HL7 FHIR Structured Data Capture



- Data collection specified using the same FHIR building blocks
- Can prepopulate from patient's record
- Can go back into the patient's record

- The BMJ Computable Intelligence Knowledge Graph can help by providing the list of what is relevant

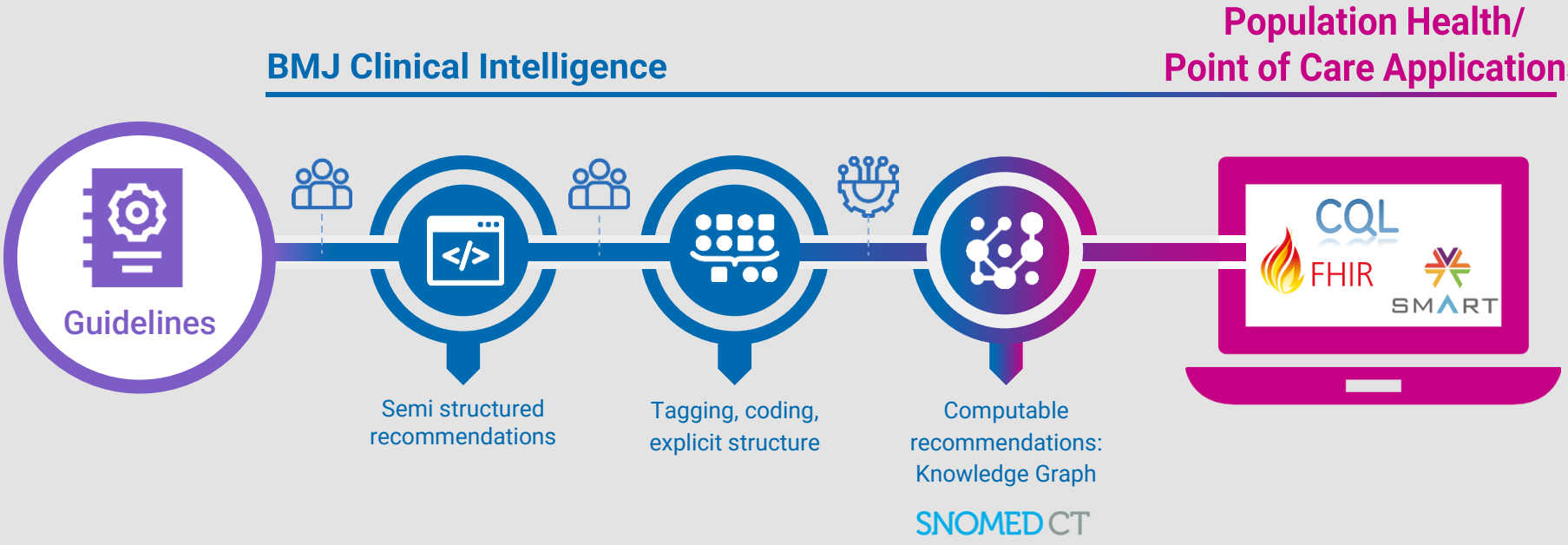
Sample form built with tools courtesy of National Library Of Medicine: https://lhcformbuilder.nlm.nih.gov/

Challenge 2

Convince people there is a problem and the solution will work

Use data and evidence based computable knowledge resources - how Clinical Intelligence will help

Getting evidence into analysis and decision support



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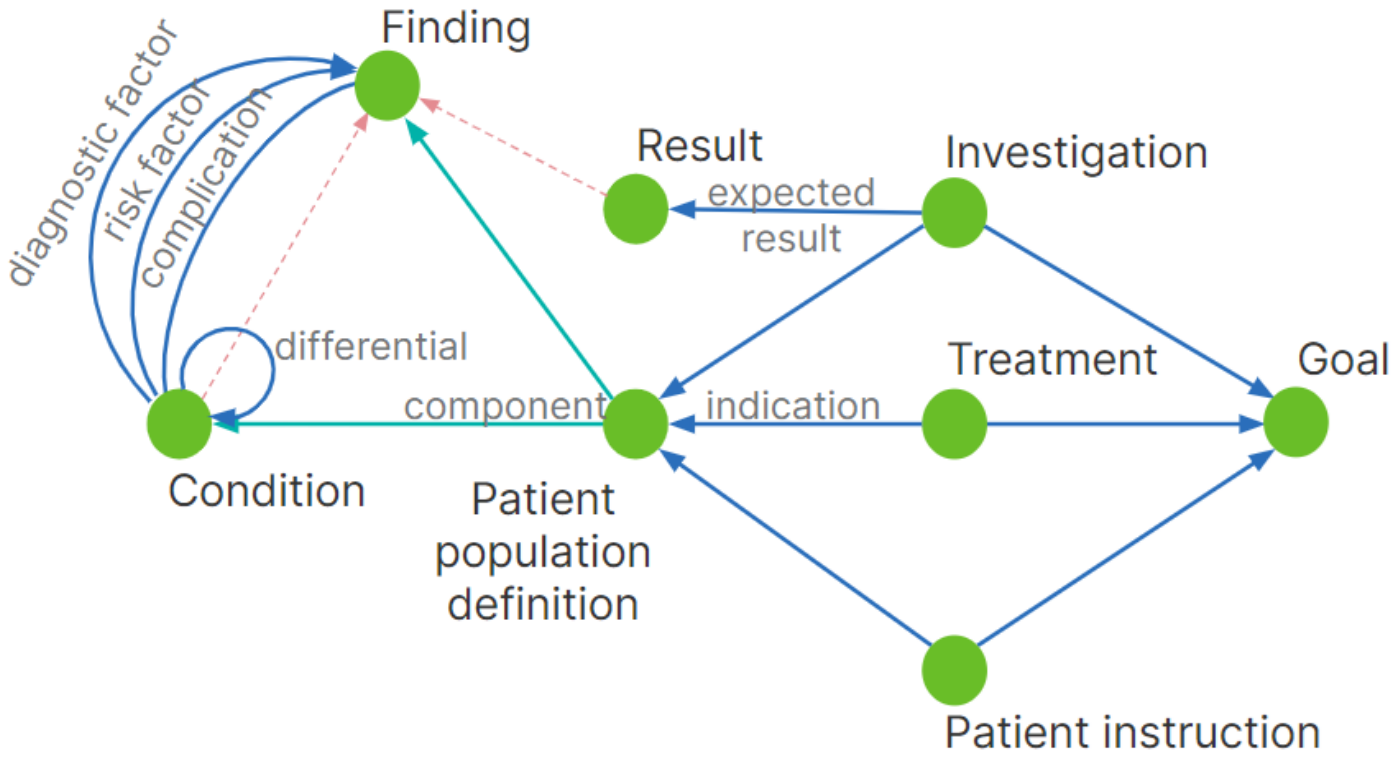
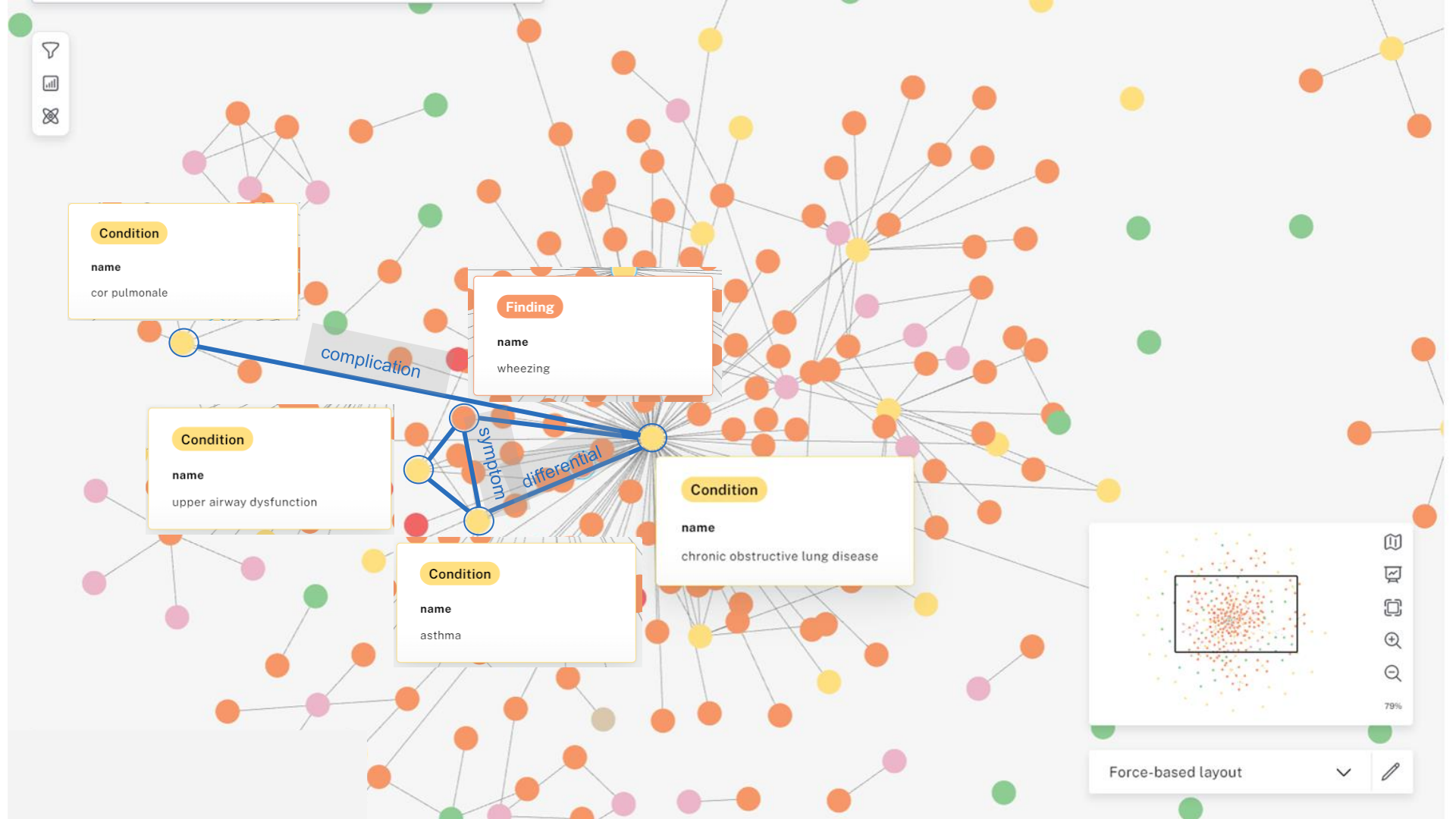
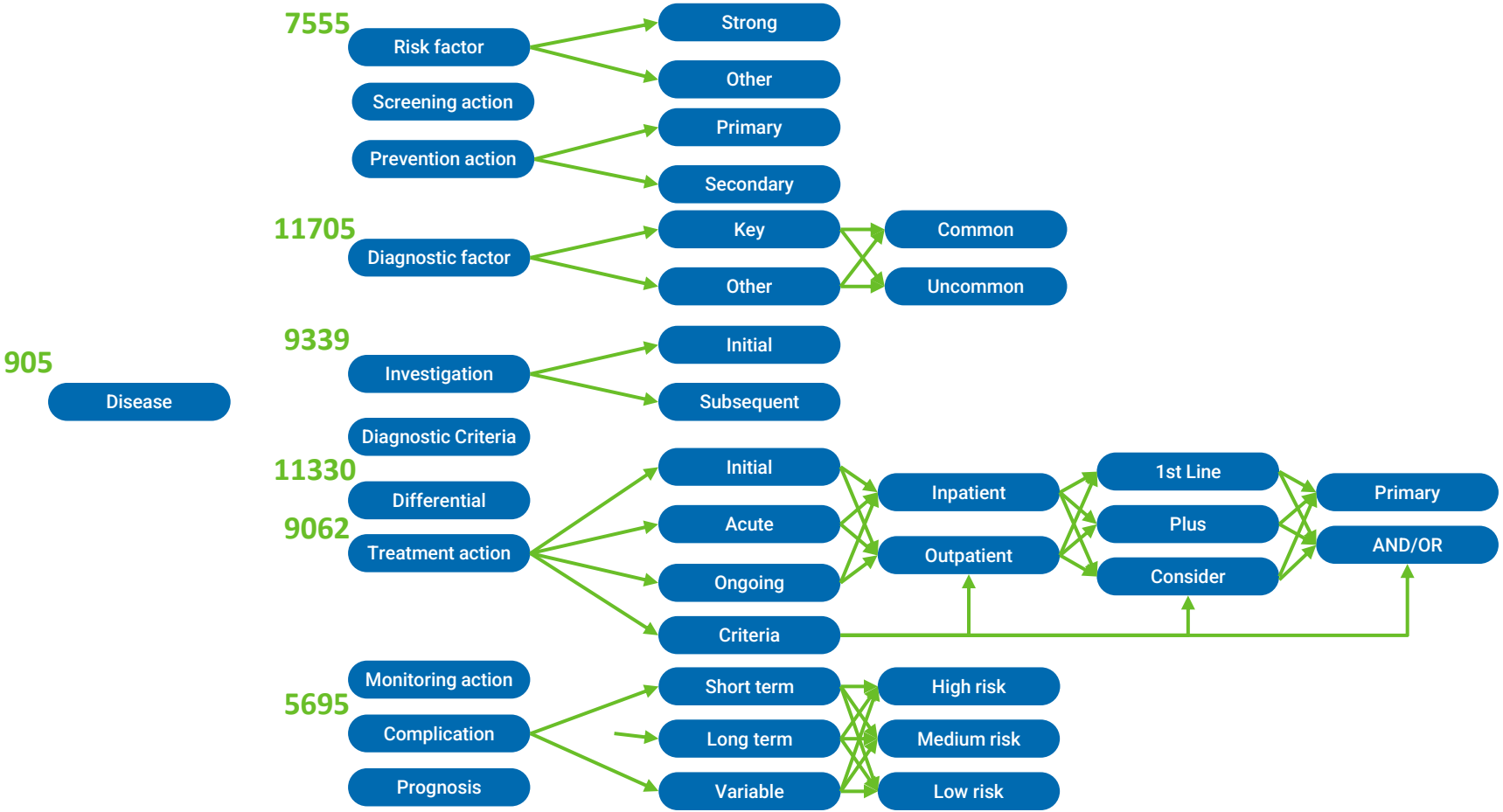
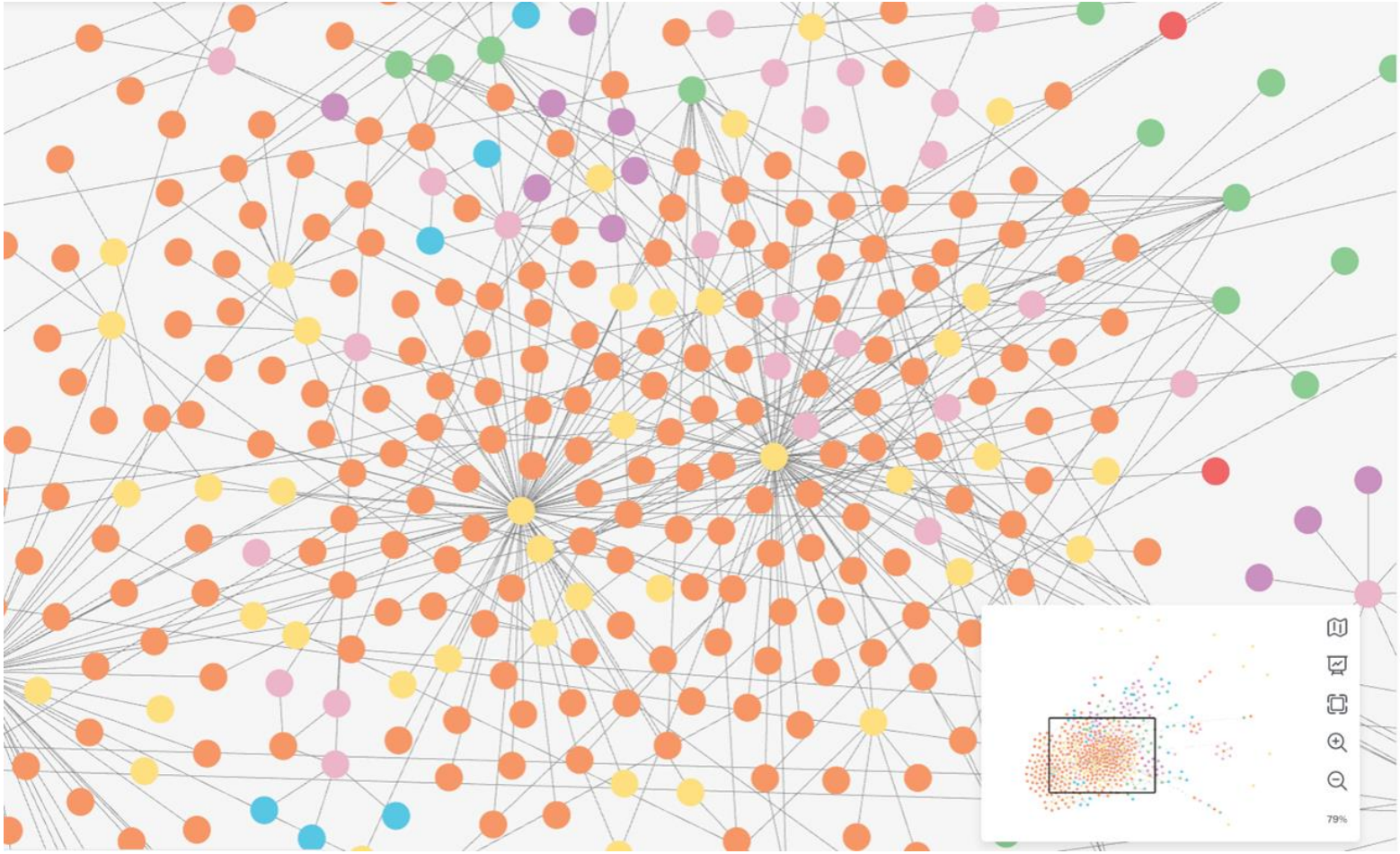
Knowledge Graph Architecture




Condition
name
cor pulmonale
complication
Finding
name
wheezing
Condition
name
upper airway dysfunction
symptom
differential
Condition
name
chronic obstructive lung disease
Condition
name
asthma
79%
Force-based layout

Knowledge Graph Architecture




Filter categories
All
In Scene
O
Component
Condition
Finding
Goal
PatientGroup
PatientInstructi
Test
Treatment
79%

Three step self-serve population analytics approach

How can we scale population health analysis to take advantage of shared knowledge?

The clinical analyst:

1. Chooses the clinical topic area or areas.
2. Defines the cohort to focus on across clinical, demographic and social features. The knowledge graph is used to support the analyst to cover those features most relevant to the clinical conditions.
3. Defines clinical metrics in terms of the take up of recommended interventions.

Enables analyst to:

- Identifies individuals that need intervention.
- Identifies process improvements if recommended interventions have been delayed, and monitors for improving trend in metrics.

Build your own Quality Metric

Dr Smith uses the knowledge graph to design her own Quality Metric, employing real-time performance dashboards to highlight patients in need of intervention.

1 Choose a clinical area

Dr Smith chooses an area of clinical interest

Clinical area: COPD

2 Refine the cohort

Dr Smith identifies the cohort of patients she is interested in

Age range: 65+ years old

Demographic features: Ethnicity: Asian, Sex: Male

Social features: Current cigarette smoker, Core 5:

Clinical features

- [ ] Select All
- [ ] Select None
- [x] CAT score >10
- [ ] CAT score <10
- [ ] Exacerbations >2 per year
- [x] Exacerbations <2 per year
- [ ] Eosinophils >150
- [ ] Eosinophils <150

Pulled from a knowledge graph query

2 Refine the cohort

Dr Smith identifies the cohort of patients she is interested in

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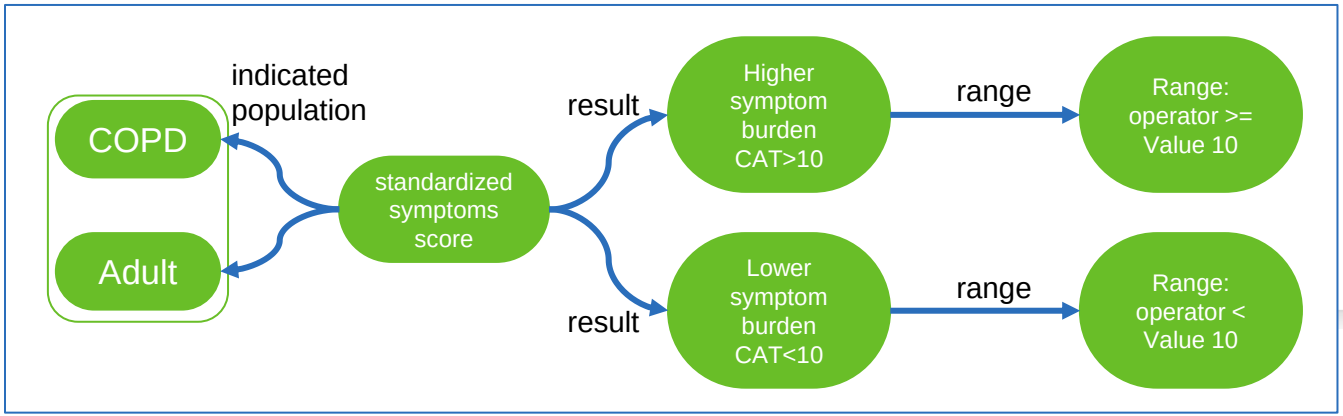
Clinical features

- ☐ Select All
- ☐ Select None
- ☑ CAT score >10



Driven from knowledge graph

2 Refine the cohort

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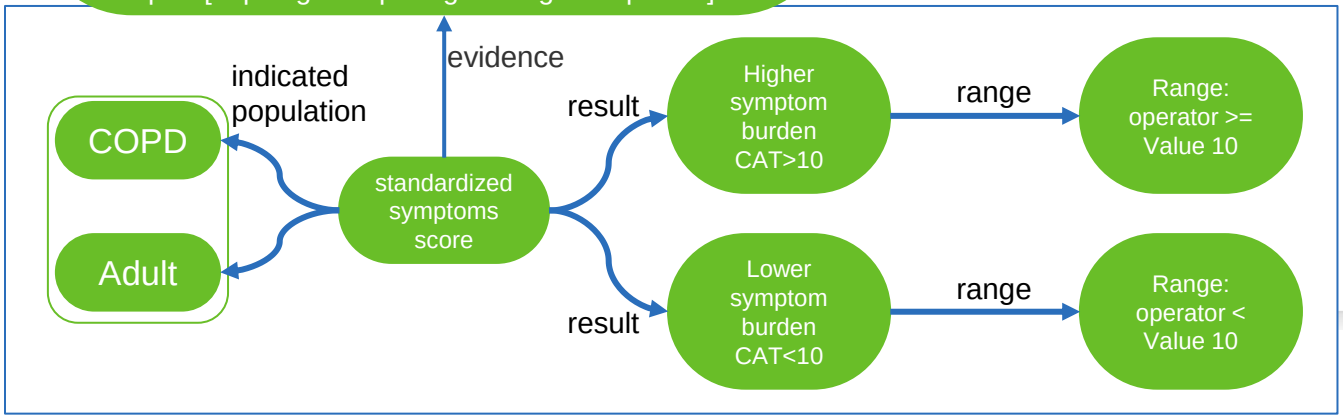
Global Initiative for Chronic Obstructive Lung Disease (GOLD). Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease: 2023 report [https://goldcopd.org/2023-gold-report-2/]



3 Choose relevant clinical metrics

- [ ] Select All
- [ ] Select None
- [x] Spirometry performed < 6 months ago
- [ ] Alpha 1 antirypsin level
- [ ] Short-acting bronchodilator (SABA) and long-acting antimuscarinic (LAMA)
- [ ] Pulmonary rehabilitation
- [ ] Inhaled technique training
- [ ] Smoking cessation training
- [ ] Flu vaccination <12 months

Pulled from a knowledge graph query

Recommended interventions

4 Prioririse patients

The knowledge graph drives the identification of those patient records that mention COPD and/or spirometry by matching to Quality Metric concepts and logic

12 patients

have COPD or Spirometry listed in their record

16% **out of 75 total patients**

Matching Quality Metric terms

Clinical description

The logic is used to highlight the patients that have COPD but not spirometry

Patient ID	Age	Sex	COPD?	Spirometry?	Matched to Quality Metric?
Liam Smith	44	M	Y	N	NO
Mason Anderson	23	M	Y	N	NO
Scarlett Garcia	42	F	Y	N	NO
Aiden Jones	55	M	Y	Y	YES

Challenge 3

Avoid unintended consequences

Patient at the centre - how Clinical Intelligence will help

5 Take action

If Dr Smith wants to stratify these patients further, she can filter by either patient name or clinical description

Name: Liam Smith, Mason Anderson, Scarlett Garc

Clinical description: Smoker, Vaping

Pulled from a knowledge graph query

Patient ID	Risk factors indentified in patient record
Liam Smith	2

Dr Smith has identified the patient(s) at highest risk, and can now send an alert to invite them to undergo spirometry

Name: Liam Smith

Send alert

Move to point of care setting

6 Identify gaps in care

BMJ Clinical Intelligence then analyses the patient record and shows when concepts match. It also highlights areas where a match is expected based on guidelines, but does not appear in the record

Section: Treatment

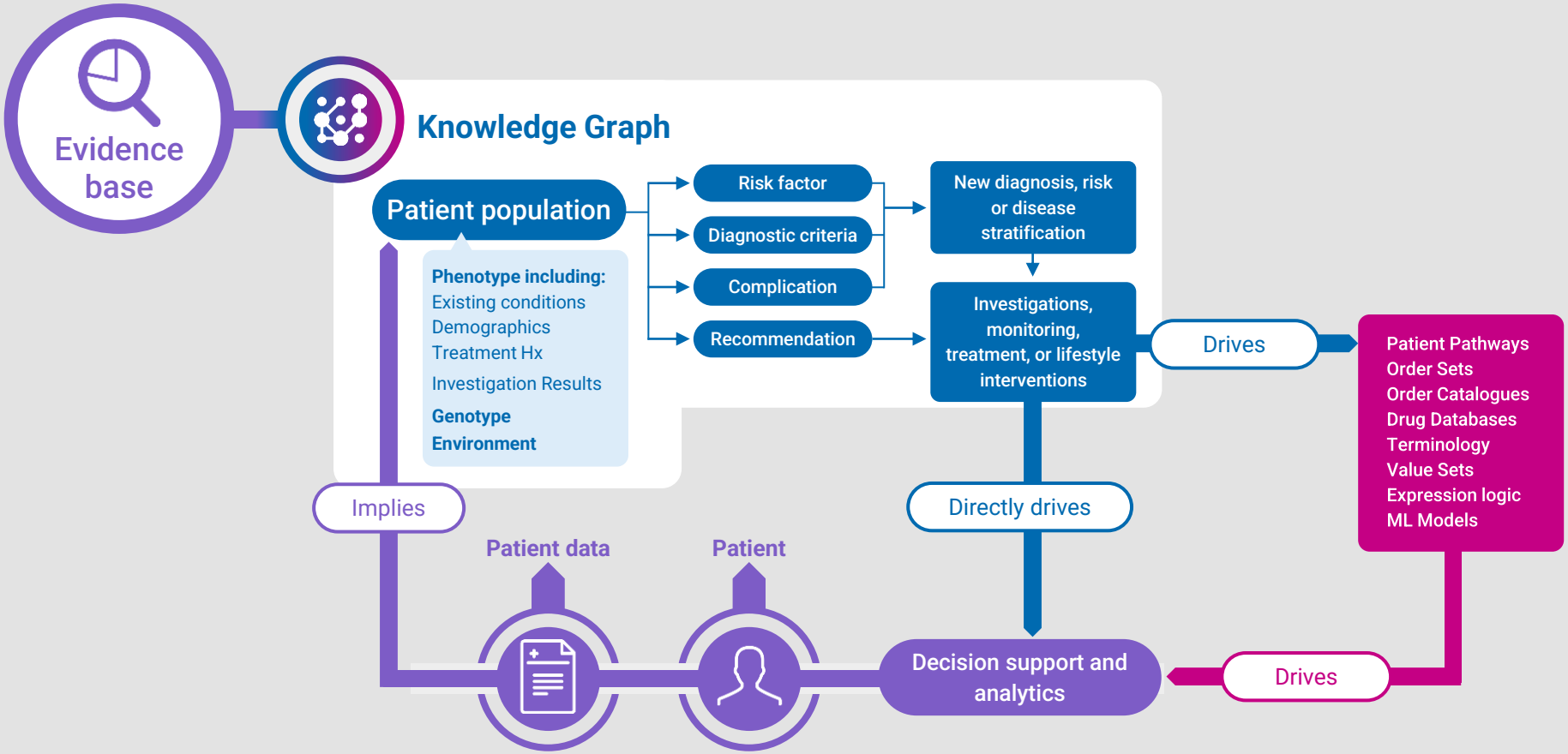
Description	Date	Match?
Pulmonary rehabilitation	Wed Jul 28 2021	YES
Adm of influenza vaccine	Wed Jul 21 2021	YES
Adm of SARS-CoV-2 vaccine	Wed May 26 2021	YES
SABA (Salbutamol)	Wed Feb 17 2021	YES
Adm of Varicella-zoster vaccine		NO
Device education		NO
LABA/ LAMA (Umeclidinium / vilanterol inhaled)		NO
Smoking cessation therapy		NO
Streptococcus vaccination		NO

Challenge 4

Securing sustainability

Employ cognitive aids directly in the clinical workflow - how Clinical Intelligence will help

Sustainable patient centred cycle



Discussion: Introduce yourself to the person in front or behind you, or carry on discussing with the same person as before. Have a 5 min discussion on:

- How are you closing care gaps with digital health to create a Learning Health System?
- How might you use BMJ Clinical Intelligence in your organisation?

Revisiting the Big Ideas

The practice of medicine is evolving in fundamental ways

- **Gather clinical data once** as a by-product of the clinical encounter (reduce physician burden), and all related community/public health data, social determinants of health
- **Reuse all data** for **all purposes**: Treatment, payment and operations (TPO), quality reporting, clinical decision support, operations improvement, public health, research/discovery (digital twins)
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- **Engage the patient** as a care collaborator – data acquisition, support self-care, shared-decision making
- **Employ cognitive aides** to augment clinical reasoning - by patient and by provider
- Create **computable knowledge** artifacts for all of the above – make them readily shareable and usable

Do all of this at scale – *standardize, streamline, and simplify*

Download BMJ Clinical Intelligence white paper

The BMJ Clinical Intelligence knowledge graph: how its functionality and structure support healthcare delivery

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Thank you

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Dr Chris Wroe: cwroe@bmj.com

Visit us at the **BMJ booth** to find out more