How do Integrated Care Systems Programme Prevention, Precision & Payment?

Iain Buchan
Associate Pro Vice Chancellor for Innovation
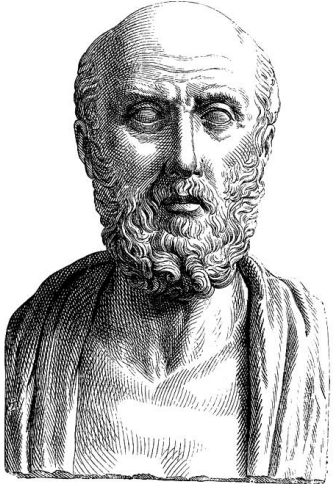W.H. Duncan Professor of Public Health Systems
University of Liverpool
buchan@liverpool.ac.uk
@profbuchan

Digital Health Rewired
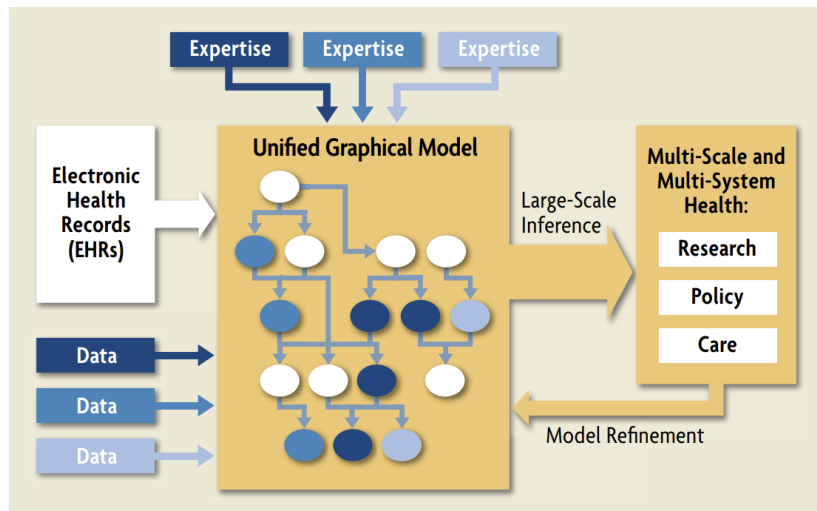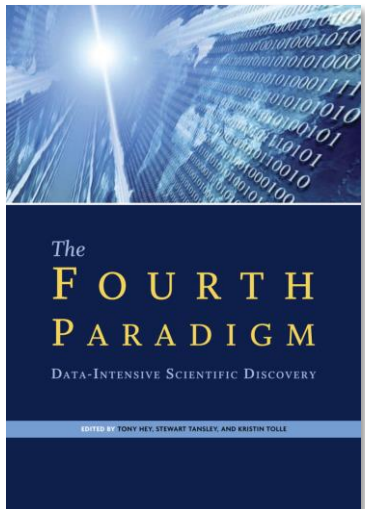Birmingham, 12th March 2024

From Hippocrates to AI: Systems Imperative

Biology not the gods cause disease

If you want to learn about the health of a population, look at the air they breathe, the water they drink, and the places where they live
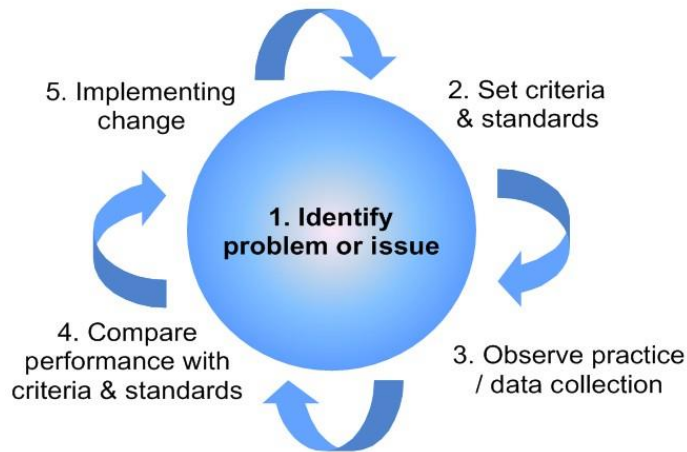
Hippocrates, 5th Century BC

Gaps after two millennia of 'medicine'

Unified, cross-disease understanding

Evolve from records (doctor-to-doctor) to AI 'avatar' (need-service broker) for personalised and preventive care

Buchan I, Winn J, Bishop C. A unified modelling approach to data intensive healthcare. in The fourth paradigm: data-intensive scientific discovery. Microsoft Research 2009. www.microsoft.com/en-us/research/wp-content/uploads/2016/02/4th_paradigm_book_part2_buchan.pdf

From Audit Loop to (Learning) System

Clinical Audit → Governance (1980s/90s → 00s)

Learning Health Systems (10s)

D2K: Data to Knowledge

K2P: Knowledge to Performance

A Health Problem of Interest

P2D: Performance to Data
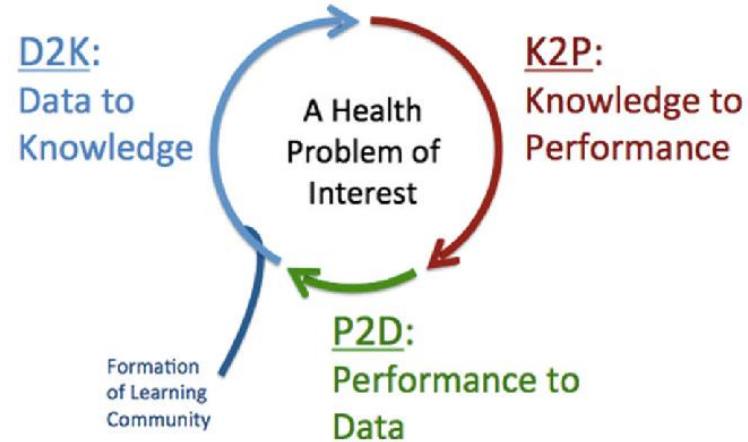
Formation of Learning Community

Health Systems (20s)

Specialist registry data

Crude predictive models
(baseline risk factor loaded)
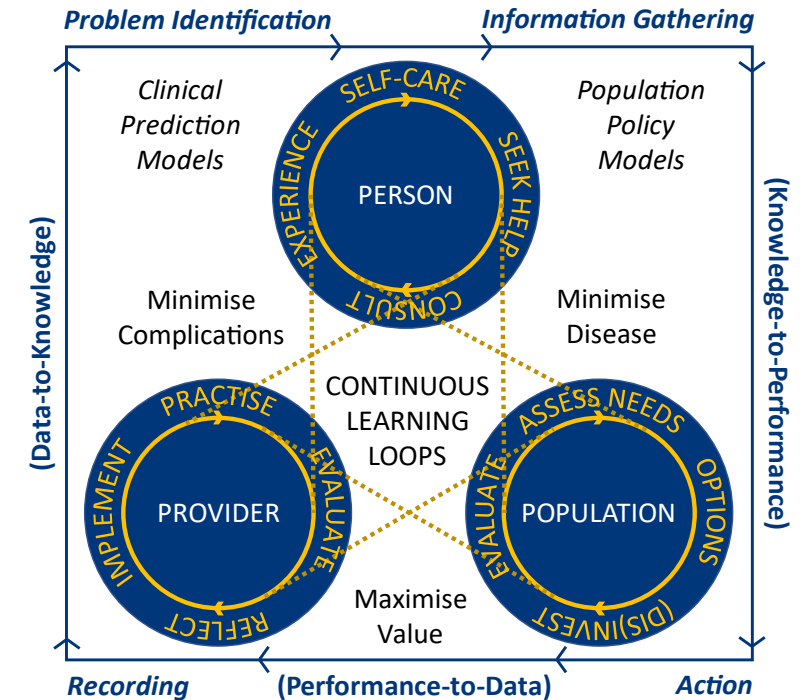
1-way translation
(trials evidence into practice)

Integrated care record data

Fuller longitudinal prediction
(difficulty learning models from data)

2-way translation aim
(practice-based evidence)

Wider civic health system data

Multi-outcome prediction
(system dynamics; causal machine learning)

Intelligence-led system / impact by design
(embedded research)

'Civic' Public Support to Bridge the Data-Action Gap

2016 & 2022: **Regional citizens' juries** asked, "should the NHS be allowed to create anonymised copies of patient records for secondary use?" saw major **shifts** from opt-in to **opt-out consent**

2016 & 2022: Public **discontent** with **national** data-sharing initiatives, which is seldom seen locally; and **patients** now **expect data-driven services**

#DATA SAVES LIVES

The Farr Institute supports the safe and trusted use of patient, research and routinely collected data for research, uniting eHealth across the UK

DATA IS IMPORTANT TO HEALTH BECAUSE...
It helps people understand patterns & trends that are key in finding practical Solutions. Shiki – Healthwatch Croydon

> "Having listened to a number of presentations from esteemed professionals, we have collaborated as a 'Jury' to express our views on proposals to use and share personal data for the purposes of addressing this important area of public health. Put simply, it is to try and find solutions to the fact that antibiotics are becoming less effective and we need to research, fund and find new treatments and drugs for the benefit of us all. Our findings will help shape policy to address these issues. "

Quote from Jury member

https://civicdatacooperative.com

TODAY Tue 25 May 2021   FACT

The Government Wants to Sell Your GP Medical Records
Here's How to Opt-Out
Phil Booth
19 May 2021

BBC
NEWS
Home | Coronavirus | Brexit | UK | World | Business | Politics | Tech | Science | Health | Family & Edu
Health
Care.data: How did it go so wrong?
Nick Triggle
Health correspondent
19 February 2014 Comme

nature   Subscribe

NEWS · 19 NOVEMBER 2019
Google health-data scandal spooks researchers
Scientists fear the controversy over the Nightingale project will undermine trust

Controversial £360m NHS England data platform 'lined up' for Trump backer's firm

Patients will have no say over records going to Palantir, the software giant run by billionaire Republican backer

CIVIC DATA COOPERATIVE

GP, Social Care Sources

Hospital Sources

Community, Public Health Sources

Patient Sources

TRUSTWORTHY LINKAGE, PSEUDONYMISATION, CODE EXECUTION

Health system 1…

Provider
Data Processing

Integrated Care System
Data Processing
Linked
Pseudonymised
Part-curated data

National Data Service
Trusted Third Party
❖ Key management
❖ Deidentification
❖ Reidentification

COMMONS
Data Catalogue
Analytic Code Books
Algorithm Library
Terminology Services
Metadata Resources
Federated Analytics

Approved Tools for
Dataset production
Data curation
Analysis & Simulation

Actionable Analytic/Trustworthy Research/Secure Data Environment (TRE/SDE) in national grid / federation
Dataset Extraction and Curation Pipeline
Audited Execution of Code on Data
Population Health Management Linked to Care Workflow

API

SDE Network

APPROACH
Open Standards
Open Development
Open Assurance
Open Maintenance
Open Innovation

COMMUNITY
Dashboard exchange
Analytic load-balancing
Shared learning resources
Predictive cooperative

OVERSIGHT

Strategic Data Insights
Steering Group

Role-based Access

CIVIC GOVERNANCE

Efficiently considering data access requests, processing agreements and monitoring data quality, curation and transferable value from innovative data processing – while driving patient, practitioner and public involvement within a region health system 'diameter of trust & actionability'

GOVERNED EXECUTION

OPEN DISCOVERY OPEN IMPACT

Three key components for closing the data-action gap:

Spring 2019
People-to-data:
Liverpool City Region
Civic Data Cooperative
civicdatacooperative.com

Summer 2020
Data-to-analysis:
NHS/social care/public health longitudinal record for 2.6m stood up in 90 days "Combined Intelligence for Population Health Action"
cipha.nhs.uk

Autumn 2020
Analysis-to-action:
World's first universal voluntary Covid-19 rapid antigen testing

- *Ainsworth J, Buchan I. Combining Health Data Uses to Ignite Health System Learning. Methods Inf Med. 2015;54(6):479-87*
- *Buchan I, National Grid of Civic Data Cooperatives for Health in The Health of the Nation February 2020*
- *www.liverpool.ac.uk/coronavirus/research-and-analysis/covid-smart-pilot/*

Liverpool City Region
COMBINED AUTHORITY

civic data coop

Covid-19 Wakeup Call for Action Ready Data

Tests & Cases

All Cheshire & Merseyside (C&M) residents tested at any Pillar 2 test site and non-C&M residents tested at a C&M test site

Note: this report does not include Pillar 1 data.

Note: positivity rate calculations do not follow PHE methodology

Show Filters | Clear Filters | Filters Applied

NHS CIPHA Combined Intelligence for Population Health Action

18,274,586	2,439,026	803,196	3.22%	15.04%
Tests Completed (LFT+PCR)	Individuals Tested (LFT+PCR)	Individuals Tested Positive (LFT+PCR)	LFT Case Positivity Rate (Asymptomatic)	PCR Case Positivity Rate (Symptomatic)

TEST COUNTS

Test Kit	Tests Completed	Positive Tests	Negative Tests	Void / Insufficient Tests
	406,360	21,834	369,056	15,470
LFT	13,394,612	430,575	12,948,537	15,500
PCR	4,473,614	659,790	3,726,918	86,906
Total	**18,274,586**	**1,112,199**	**17,044,511**	**117,876**

INDIVIDUALS TESTED POSITIVE

Test Kit	Individuals Tested	Individuals Tested Positive	Case Positivity Rate (Individuals)
	115,833	21,137	5.59%
LFT	1,666,102	315,295	3.22%
PCR	1,585,738	610,445	15.04%
Total	**2,439,026**	**803,196**	**6.13%**

TESTS OVER TIME: LFT
● Positive ● Negative ● Void/insufficient

TESTS OVER TIME: PCR
● Positive ● Negative ● Void/insufficient
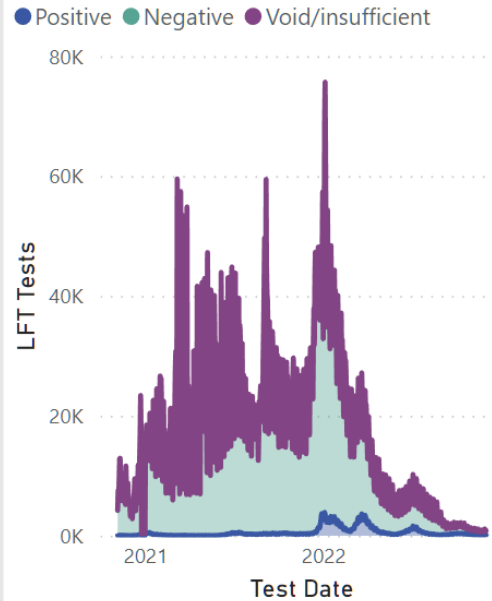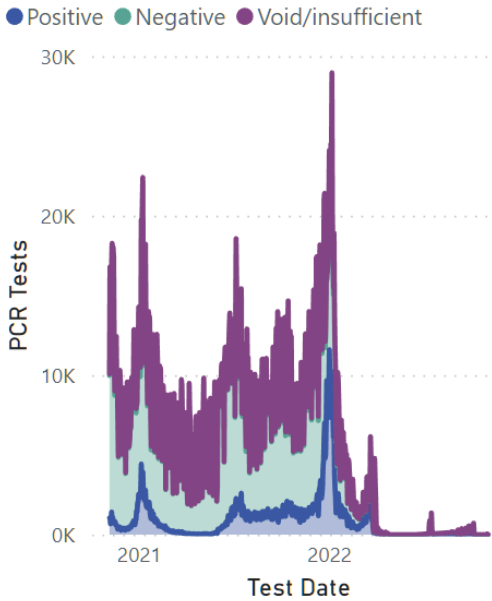
INDIVIDUALS TESTED POSITIVE OVER TIME: LFT

INDIVIDUALS TESTED POSITIVE OVER TIME: PCR

Data available up to: 25/1/2029 10:40. Run by: buchan@liverpool.ac.uk on 8/12/2022 08:11; V1.9.0

Graphnet Integrating Care

CIPHA Combined Intelligence for Population Health Action
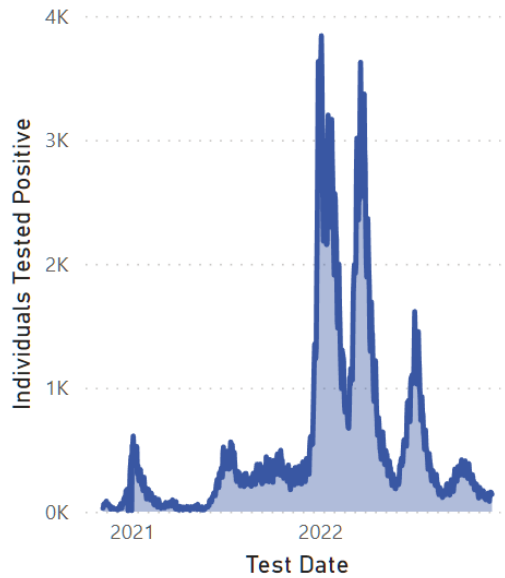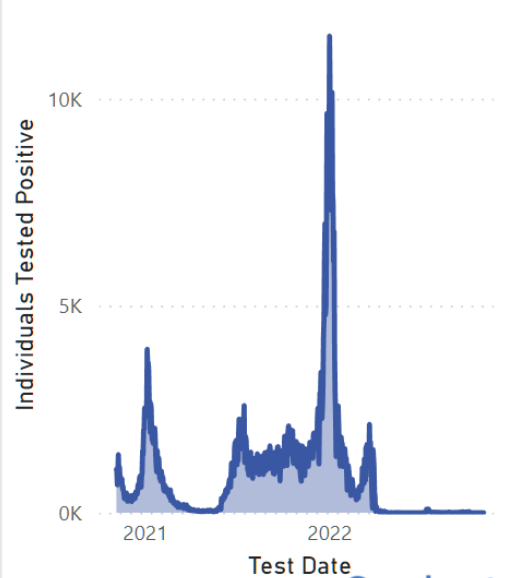
Near real-time covid testing data for 2.7m people of Cheshire & Merseyside

Linked to GP and partial hospital and social care records

Dashboards for care, planning and research

Liverpool October 2020

- COVID-19 **deaths** surge

- One of most **deprived** parts of UK
  Third of children born in poverty

- **Job-losses** surge from
  COVID-19 restrictions

- Visitors, hospitality and events
  form **half** of Liverpool's **economy**

- **Lockdowns** a public health hazard
  as well as SARS-CoV-2

ECHO

SIGN UP TO RECEIVE LIVERPOOL OR EVERTON
EMAILS AND GET A FREE PRE SEASON GUIDE
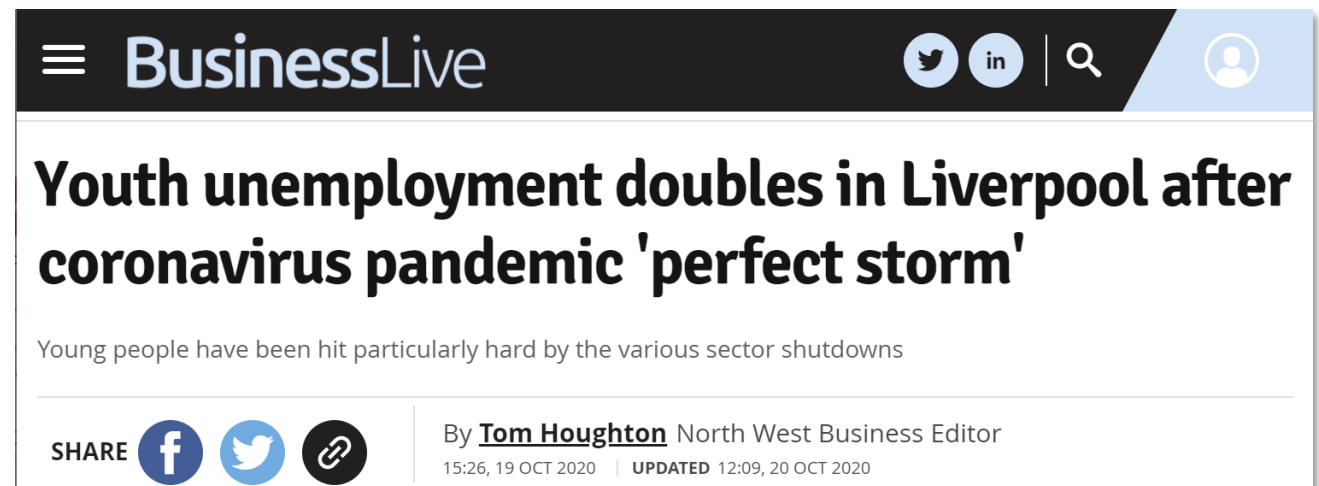
NEWS   IN YOUR AREA   LIVERPOOL FC   EVERTON FC   WHAT'S ON   CELEBS   SPORT   SPECIAL FEATURES

Liverpool NHS Trust has highest number of coronavirus patients in the whole of England

Admissions of people with coronavirus are approaching the peak levels of last spring, city hospitals boss has warned

SHARE   9 COMMENTS   By **Luke Traynor** Chief Reporter & **Liam Thorp**
10:41, 10 OCT 2020

BusinessLive

Youth unemployment doubles in Liverpool after coronavirus pandemic 'perfect storm'

Young people have been hit particularly hard by the various sector shutdowns

SHARE   By **Tom Houghton** North West Business Editor
15:26, 19 OCT 2020 | **UPDATED** 12:09, 20 OCT 2020

Liverpool November 2020: Rapid Testing Pilot Impactful

- World's **first city-wide pilot** of testing for people without COVID symptoms to save lives and livelihoods

- **Quarter** of population **volunteered** in a month despite external media negativity

- **Case detection increased** by a **fifth**

- **Known case rate fell** by a **fifth**
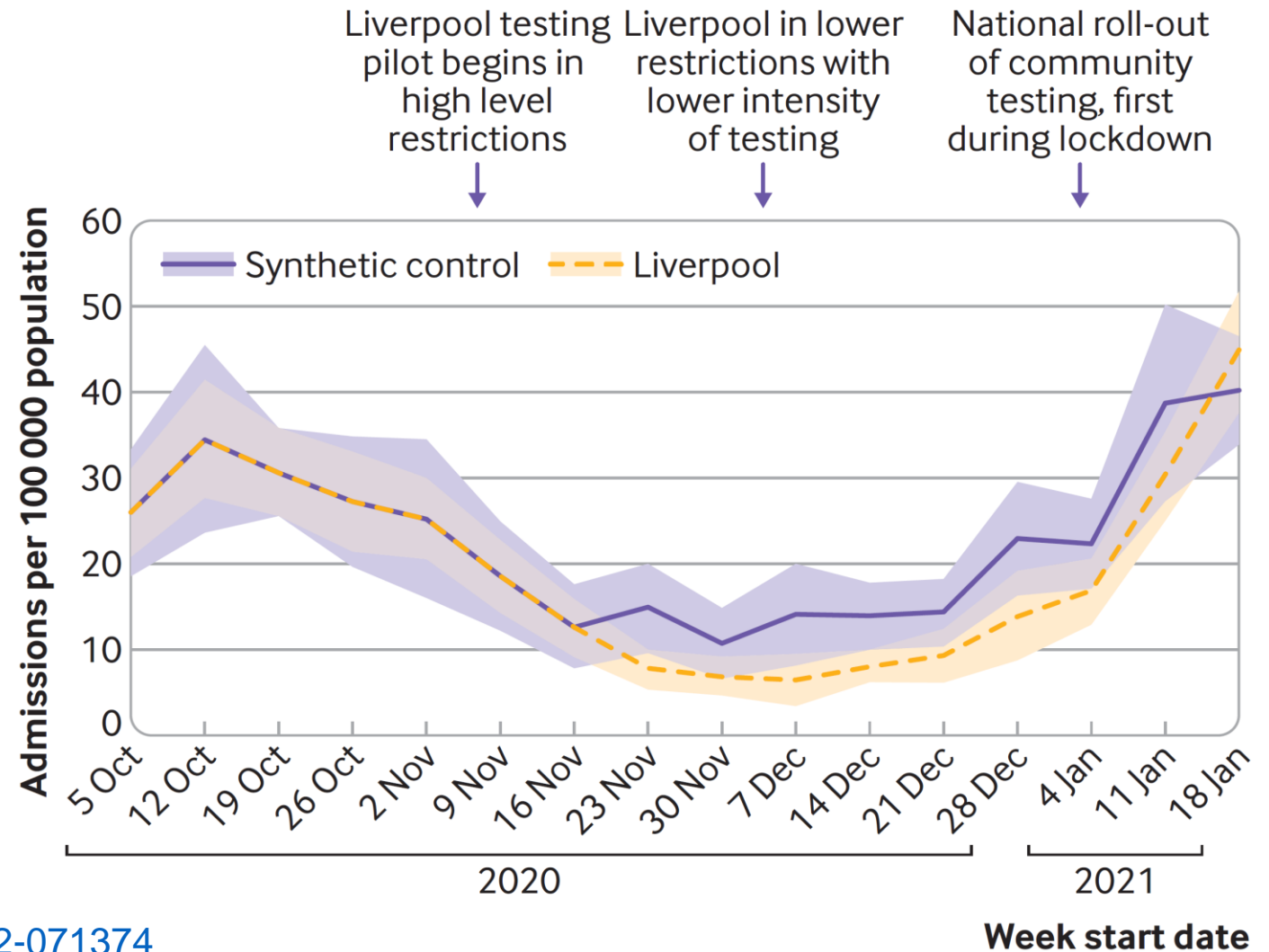
- **Hospitalisation fell** by a **quarter**

www.bmj.com/content/379/bmj-2022-071374

www.liverpool.ac.uk/coronavirus/research-and-analysis/covid-smart-pilot/

Impact of 'Mass Testing' Pilot on Covid-19 Hospitalisations

- **Synthetic control** analysis making neighbourhoods similar in terms of background risks, epidemic and control measures

- Initial mass testing with military: **43%** (29% to 57%) **reduction** in COVID-19 hospital admissions

- Overall community testing pilot with handover to local services **25%** (11% to 35%) **reduction**

- Results: https://www.bmj.com/content/379/bmj-2022-071374
- Methodology: https://www.bmj.com/content/379/bmj.o2712
- Policy impacts: www.liverpool.ac.uk/coronavirus/research-and-analysis/covid-smart-pilot/

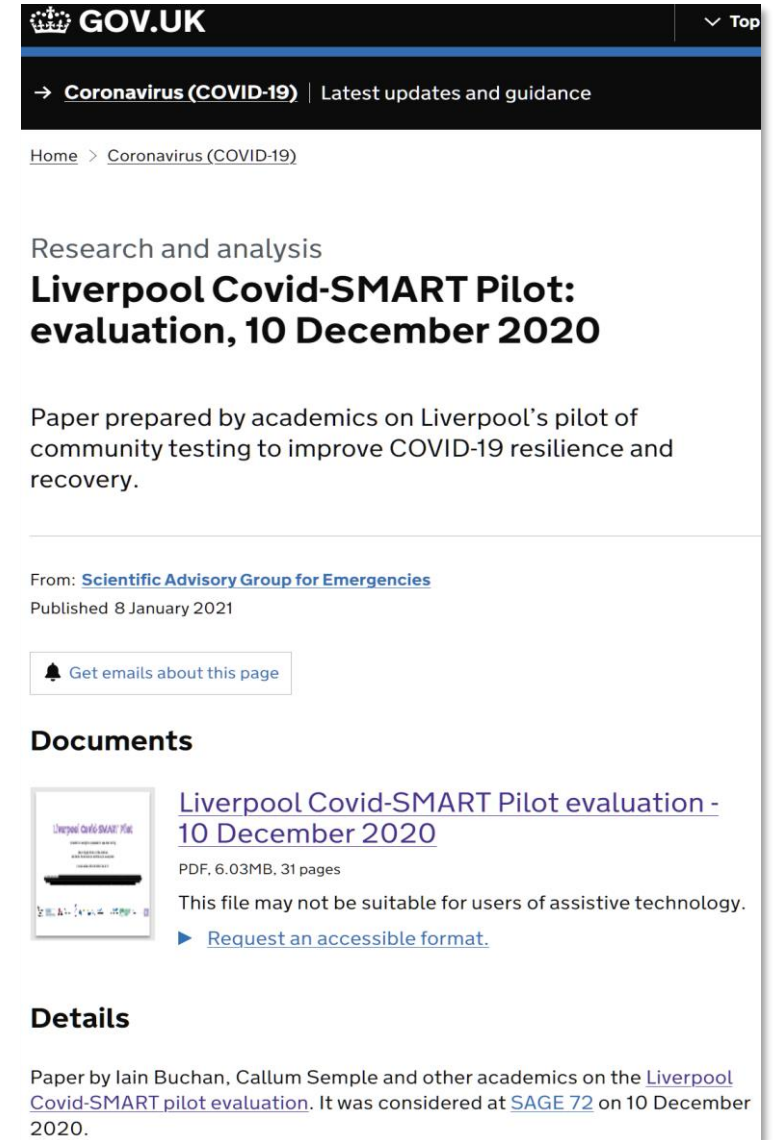# Digital Poverty → Low Test Uptake: Need Universal Access
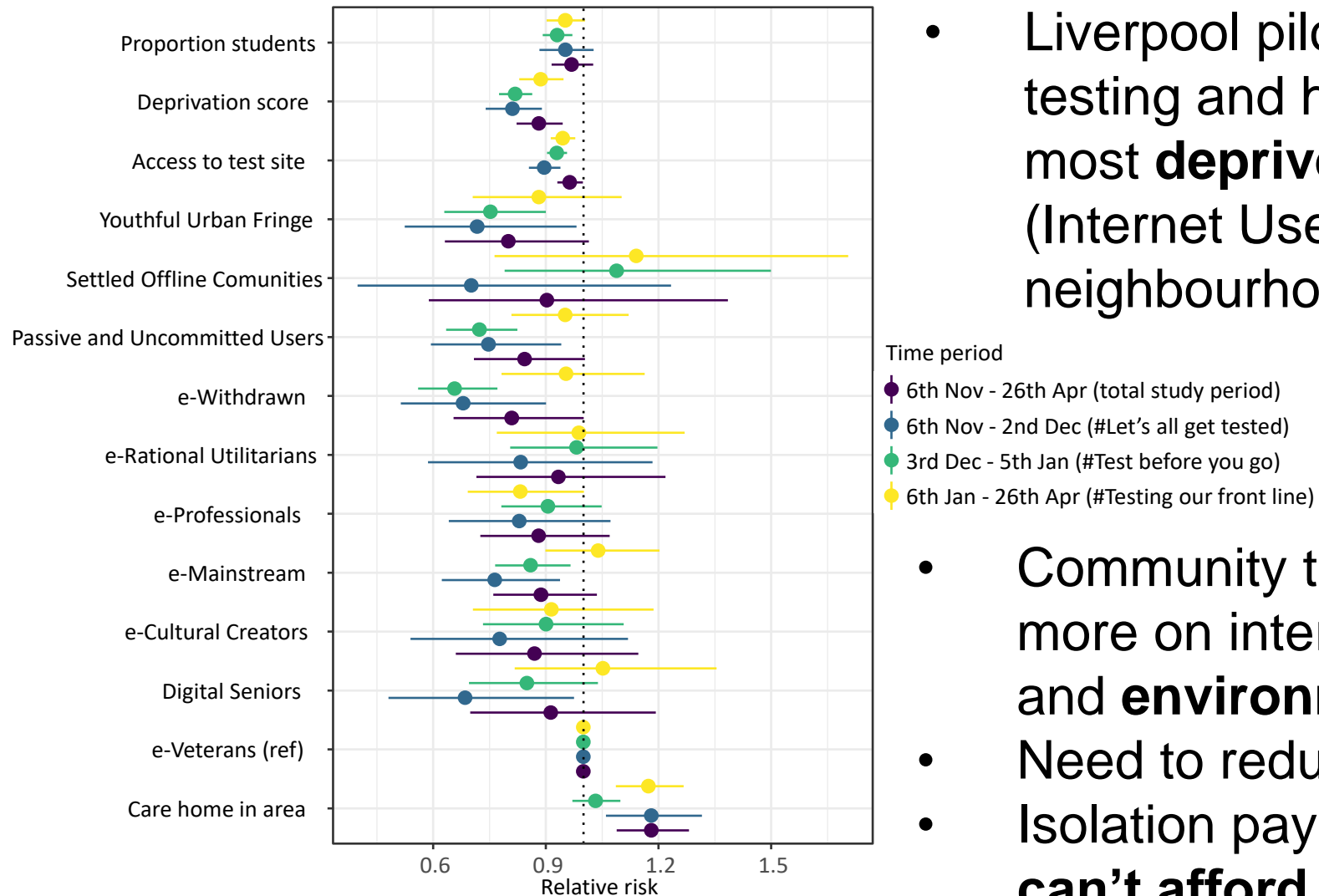
- Liverpool pilot demonstrated **lower uptake** of testing and higher infection rates among the most **deprived** and the **digitally excluded** (Internet User Classification of neighbourhoods)

- Community testing roll-out advised to focus more on interactions of **biology**, **behaviour** and **environment** (end-to-end testing)
- Need to reduce **digital complexity**
- Isolation payments needed for those who **can't afford to isolate**

www.thelancet.com/journals/lanepe/article/PIIS2666-7762(21)00084-3/fulltext

London December 2020: Community Testing Policy Made

- End-to-end testing **evaluation** considered by UK Scientific Advisory Group for Emergencies and Universal Access Community Testing **policy** made

- Media **debate** over 40% lateral flow sensitivity vs PCR, confusing clinical test of having been infected with public health test of being ~infectious

- Public health utility function to optimise:
  1/time to % appropriate action (e.g., isolation)
  30 min lateral flow vs 48h PCR
  consider '**actionable accuracy**'

Mina MJ, Peto TE, García-Fiñana M, Semple MG, Buchan IE. Clarifying the evidence on SARS-CoV-2 antigen rapid tests in public health responses to COVID-19. Lancet. 2021 Apr 17;397(10283):1425-1427
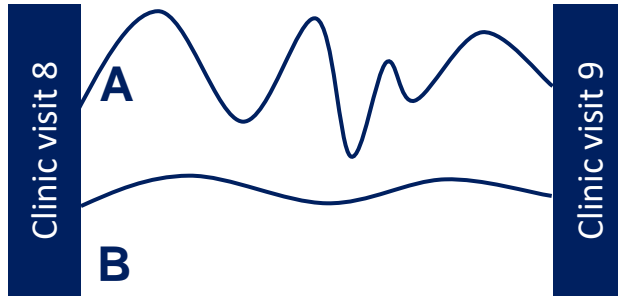
Digital Twin from Records or Self-experiment Avatar?

Sparse NHS records of clinical 'pit-stops'
Digital by-products of health, habits and self-care experiments
Rhythms of life to tap for discovery, engagement and intervention
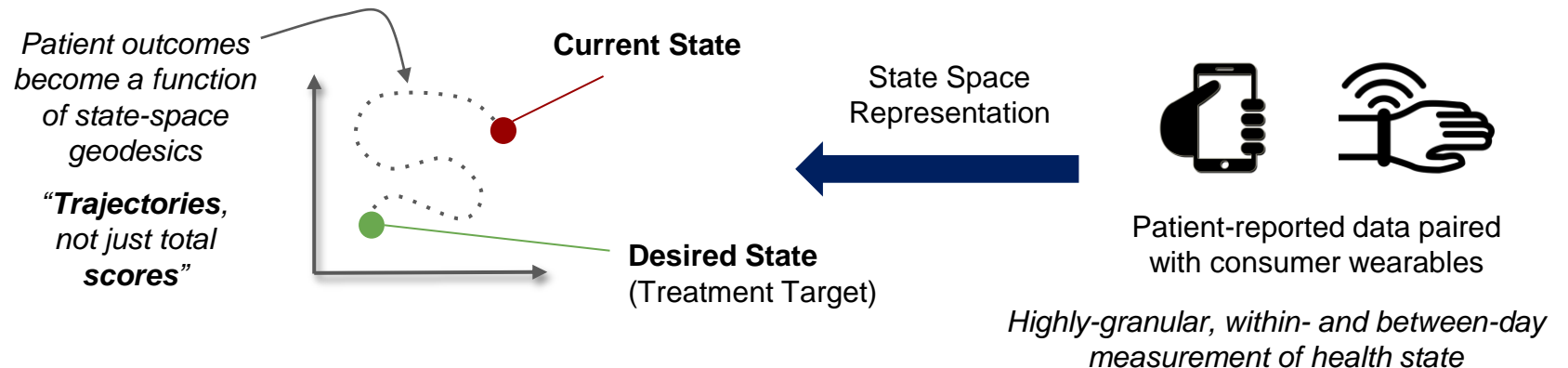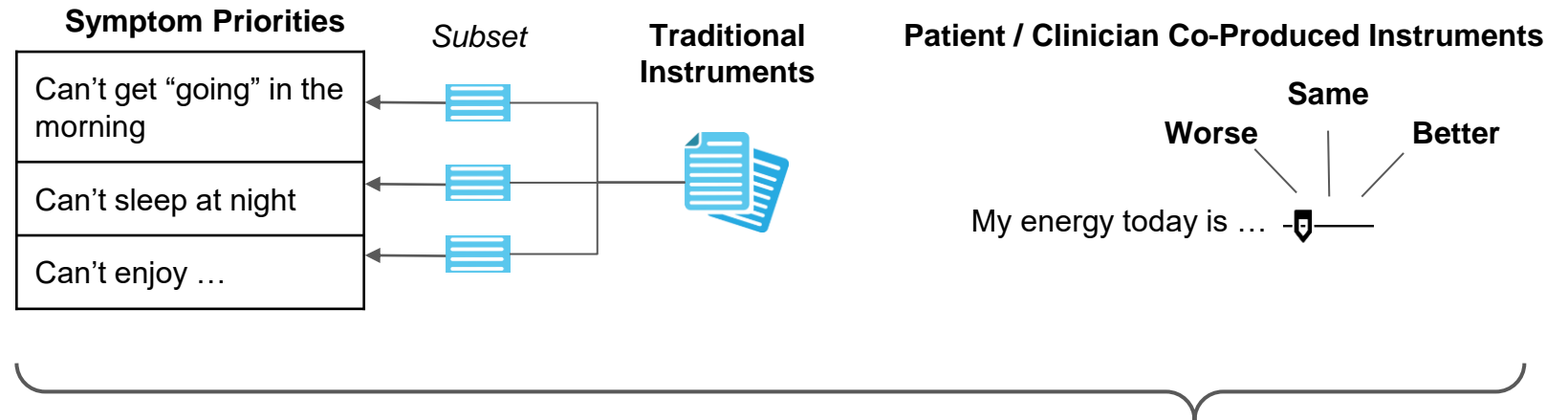
Apps → Avatar Skills and Measurement Based Care

Clinic visit 8

A

B

Clinic visit 9

Two patients:

- **Same diagnosis / treatment**
- **Different conditions / needs**
- **Key rhythms invisible to clinic**

App market failure:

- **Blizzard of apps for drugs, devices, clinics etc.**
- **Patient burden too high**
- **More people living longer with more than one condition**
- **Combinatorial explosion of complexity and confusion**
- **Lack of transparency & trust**

Symptom Priorities

Can't get "going" in the morning
Can't sleep at night
Can't enjoy …

Subset

Traditional Instruments

Patient / Clinician Co-Produced Instruments

Same

Worse   **Better**

My energy today is …

Patient outcomes become a function of state-space geodesics

*"**Trajectories**, not just total **scores**"*

Current State

Desired State (Treatment Target)

State Space Representation

Patient-reported data paired with consumer wearables

Highly-granular, within- and between-day measurement of health state

TREAT THE PATIENT NOT THE DIAGNOSIS AND MANAGE THE JOURNEY NOT THE VISIT

Linked Digital Twins: Health Avatar & Learning Health System

Health Avatar (interactive digital-self for healthcare) technology for tapping into the rhythms of life, sampling symptoms and biology adaptively – revealing mechanisms not manifest at clinic visits

Actions

Insights

Questions

← Understand Mechanisms

Explain Variation →

Biology ∪ Behaviour ∪ Environment

Mechanism knowledge

Measurement Error

Data

Missingness

Causal inference and counterfactual prediction in machine learning for actionable healthcare | Nature Machine Intelligence

Millions of health avatars training and testing AIs in better care would reveal temporal (transdiagnostic) patterns and enable adaptive observation and serial experimentation for new discovery

Problem Identification　　*Information Gathering*

Clinical Prediction Models

Population Policy Models

SELF-CARE
EXPERIENCE
SEEK HELP
CONSULT
PERSON

Minimise Complications

Minimise Disease

(Data-to-Knowledge)

(Knowledge-to-Performance)

CONTINUOUS LEARNING LOOPS

PRACTISE
IMPLEMENT
EVALUATE
REFLECT
PROVIDER

ASSESS NEEDS
OPTIONS
EVALUATE
(DIS)INVEST
POPULATION

Maximise Value

Recording　　**(Performance-to-Data)**　　*Action*

The promise of 'learning health systems' will not be realised without 'discovery grade' data, causal inference and experiments

Engineering Antimicrobial Stewardship with Patients & GPs

- **10m deaths/year** worldwide by **2050** if do nothing

- Too **few new** antibiotics, antivirals, antifungals

- Microbes become **resistant** to these drugs **naturally**

- **Careless use** of antimicrobials **breeds resistance**

- **Patient expectations** and prescriber actions interact

Take infection prevention and control measures

Combine predicted and observed intelligence

Evaluate infection intervention outcomes

Predict threats (biological, behavioural, environmental)

PATHOGEN — INFECT · RESIST · SPREAD · EVOLVE

PERSON — SELF-MANAGE · SEEK HELP · RECEIVE HELP · PLAN

POPULATION — ASSESS NEEDS · OPTIONS · (DIS)INVEST · EVALUATE

PROVIDER — PRACTISE · EVALUATE · REFLECT · IMPLEMENT

Engineering better antimicrobial stewardship needs to work with nature's pathogen 'learning system'

And join up…

Population-level actions on antimicrobial restrictions and tracking resistance

Provider-level actions on rational prescribing

Person-level actions on demand for, and uses of, antimicrobials