



UNIVERSITY OF  
LIVERPOOL



LIVERPOOL CITY REGION  
COMBINED AUTHORITY



# Civic Data Cooperatives for Health Inclusive Health Innovation in Smarter Cities

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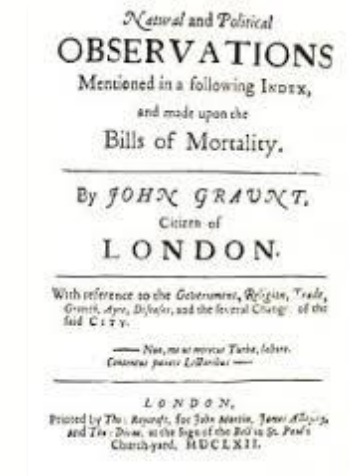
Building Smart Cities with Citizens and for the Public Good

Heseltine Institute, Liverpool

9<sup>th</sup> March 2020

# London 1600s: Plague & Surveillance 'Socialism'

Parish (deaths)	Number of hearths (fireplaces) as a proxy for house size and over-crowding							
	1	2	3	4	5	6	7	8+
St James Clerkenwell (44)	31.7 <b>39.8</b>	20.8 <b>19.3</b>	24.7 <b>16.7</b>	9.7 <b>7.3</b>	2.6 <b>3.9</b>	3.2 <b>2.7</b>	1.2 <b>1.9</b>	6.2 <b>8.4</b>
St Botolph without Aldgate (41)	31.2 <b>26.5</b>	25.2 <b>33.1</b>	22.3 <b>24.4</b>	8.3 <b>5.1</b>	4.7 <b>3.8</b>	4.7 <b>4.1</b>	1.5 <b>1.5</b>	2.2 <b>1.7</b>
St Dunstan in the West (49)	15.5 <b>10.7</b>	11.7 <b>7.5</b>	12.6 <b>7.3</b>	20.2 <b>14.3</b>	8.6 <b>11.9</b>	5.0 <b>10.5</b>	4.7 <b>8.7</b>	21.7 <b>29.1</b>
St Michael Queenhithe (20)	35.1 <b>24.3</b>	24.3 <b>12.9</b>	16.2 <b>20.0</b>	5.4 <b>7.1</b>	5.4 <b>15.0</b>	2.7 <b>10.0</b>	2.7 <b>2.1</b>	8.1 <b>8.5</b>
St Saviour Southwark (42)	14.2 <b>30.0</b>	31.8 <b>33.5</b>	28.2 <b>20.1</b>	12.4 <b>7.5</b>	6.9 <b>3.8</b>	4.3 <b>2.9</b>	0.7 <b>0.9</b>	1.5 <b>1.3</b>



From: *Epidemic Disease in London*, ed. J.A.I. Champion (Centre for Metropolitan History Working Papers Series, No.1, 1993): pp. 35-52

<https://www.geog.cam.ac.uk/people/newton/GrauntSymposiumPaper.pdf>

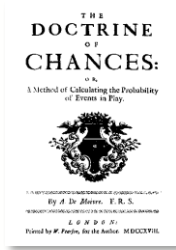
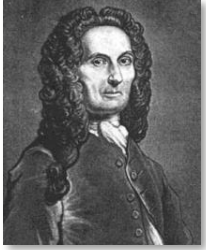
Epidemiology and politics preceding the Great Plague of London (1665; 25% population die) followed by the Great Fire of 1666 then social and structural reform.

*...any man's death diminishes me, because I am involved in mankind, and therefore never send to know for whom the bells tolls; it tolls for thee.*



John Donne,  
London 1624

# Health Data 'Computing' Revolution by 1841

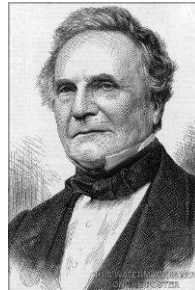


1700s: Bernoulli & DeMoivre introduce **probability theory** to quantifying (health) risks  
triggers Bayes 50 years later... still influencing today's AI



Early 1800s: Laplace then Louis apply **probability theory** to showing some **treatments** to be **ineffective**  
– **rebuked** by medical profession  
– Quetelet's concept of the '**average man**' enrages establishment

1841: Letting data speak through automation (difference engine)...



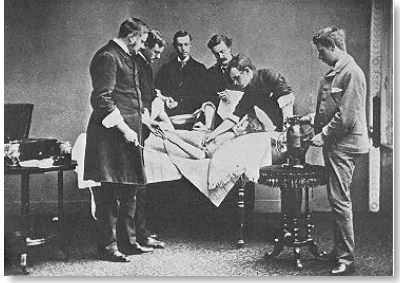
Babbage  
(1791-1871)



Farr  
(1807-1883)

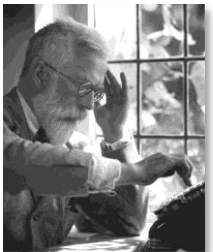
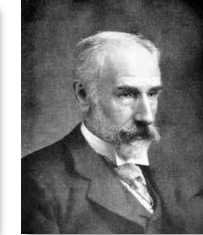
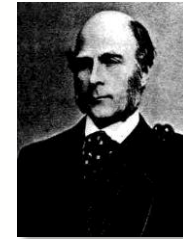
Long-division for life tables → **public health reforms**

# Evidence Based Care: Information to Action



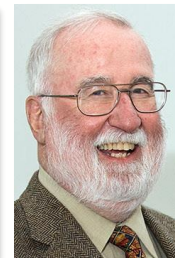
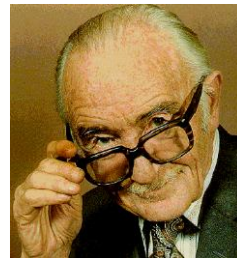
Late 1800s: Lister uses **statistical arguments** and Pasteur's germ theory to **revolutionise surgery** with carbolic spray

Early 1900s: **Statistical Movement**, strong in Agriculture and emerging in Medicine



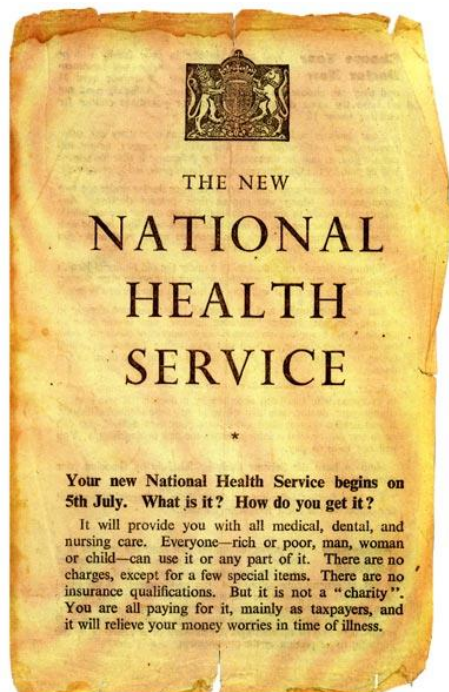
Mid 1900s: **Experimental** (statistical) discipline into **Medicine** and **NHS** founded (1948)

1970-80s onward: Disciplined implementation of **evidence into practice**





# NHS Data Standards and Early Computing



Needs-based  
since 1948

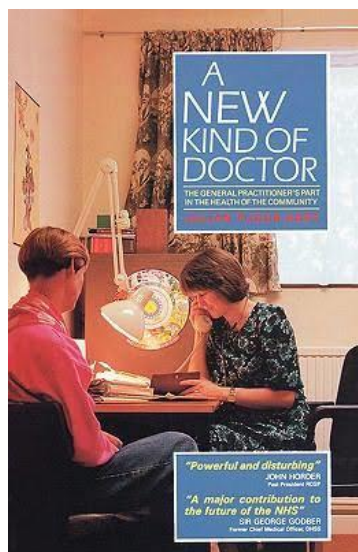
Has striven to  
measure needs



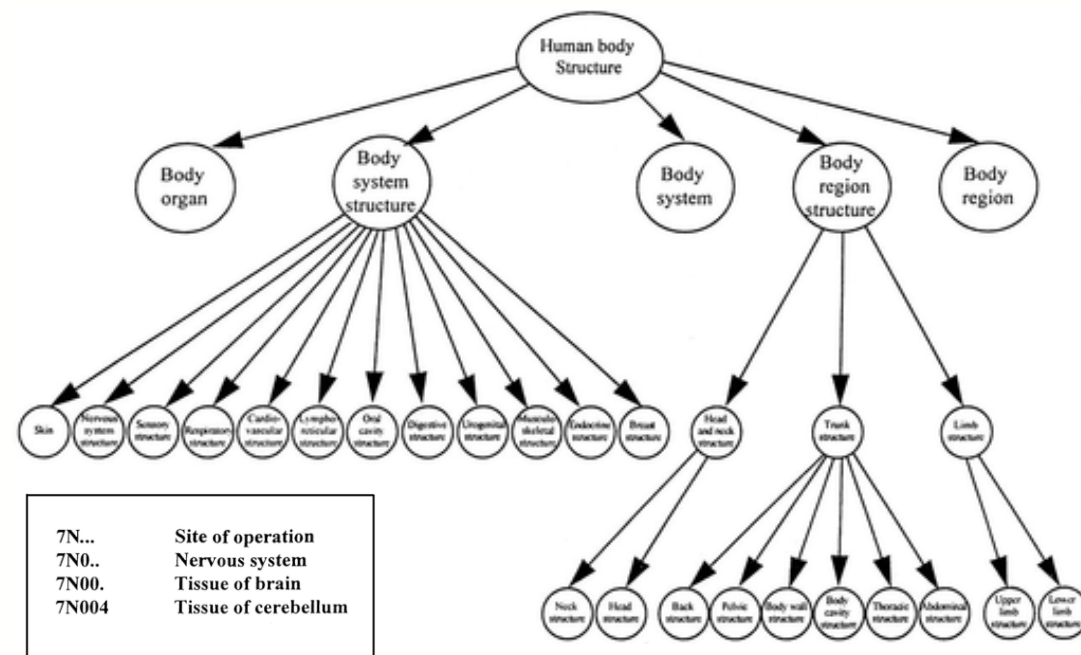
## The Inverse Care Law

- The availability of good medical care tends to vary inversely with the need for the population served.

Julian Tudor Hart. The Lancet: Saturday  
27 February 1971



## NHS GPs using computable codes for 35 years



Data to drive NHS needs-based policies and care: -

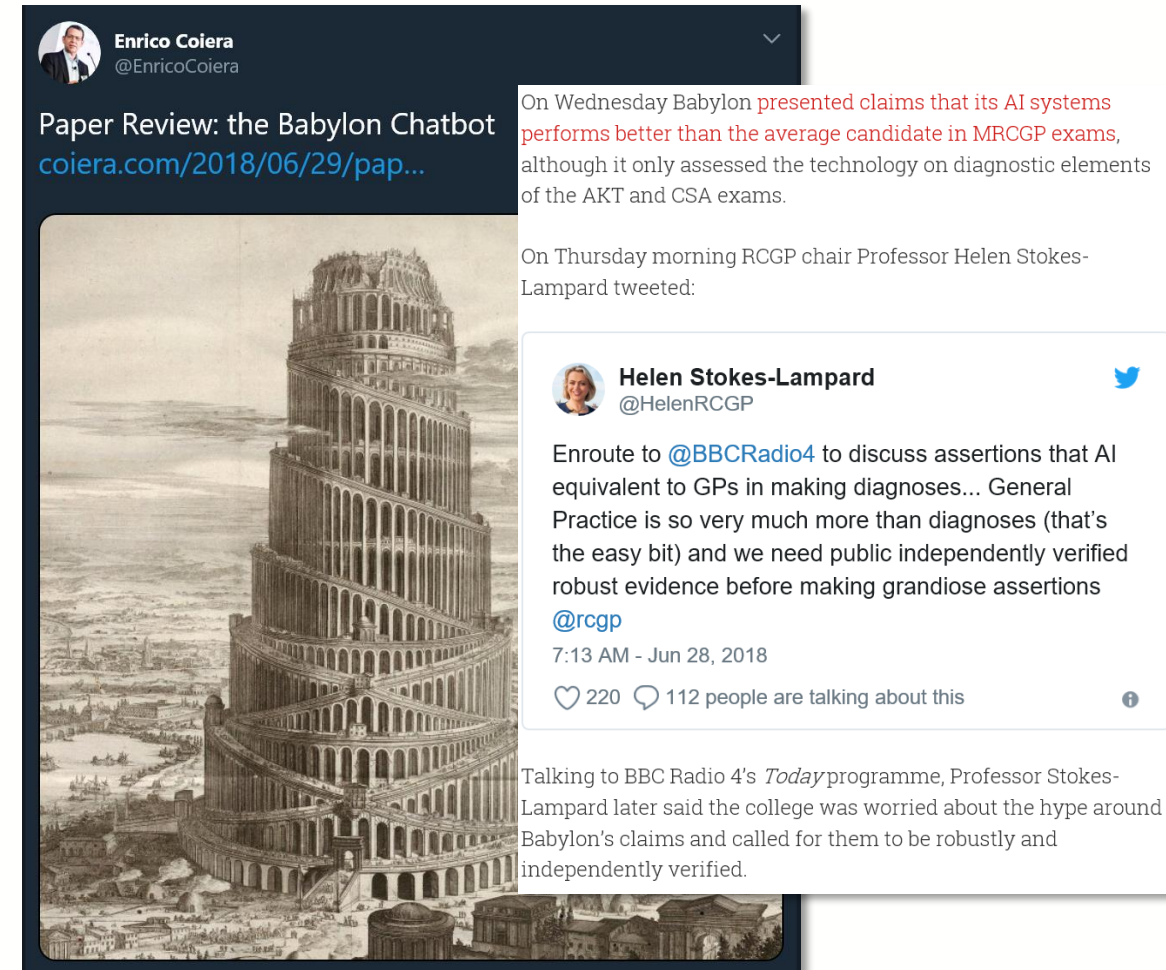
- Körner review by 80s: standard data to compare hospitals
- Computers for GPs in exchange for research data in 80s/90s
- Quality management and decision-support from 00s...

# From IT for GPs to Specious 'AI GPs' for Patients

1988 AAH MEDITEL advertisement courtesy of T. Benson



Schulz EB, Price C, Brown PJ. Symbolic anatomic knowledge representation in the Read Codes version 3: structure and application. J Am Med Inform Assoc. 1997 Jan-Feb;4(1):38-48.

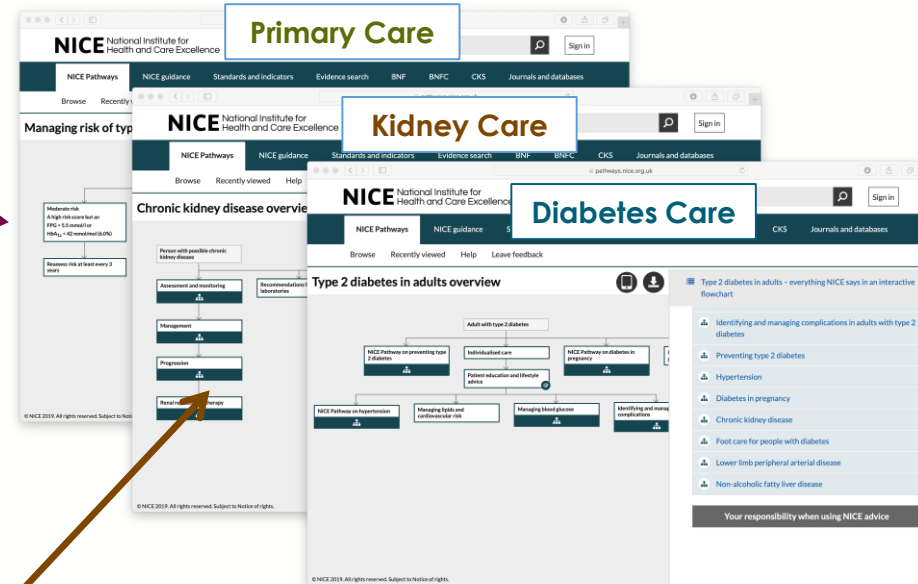


[coiera.com/2018/06/29/paper-review-the-babylon-chatbot/](https://coiera.com/2018/06/29/paper-review-the-babylon-chatbot/)

# Data Tsunami, Analytic Blizzard, Information Drought

GP and social care...

Smoking cessation; social support; weight control



Kidney clinic...

Blood pressure control

↑ BP

↑ Weight



Eric...

63y; type 2 diabetes; high blood pressure; chronic kidney disease; overweight; smoking; depression; wife with dementia

Diabetes clinic...

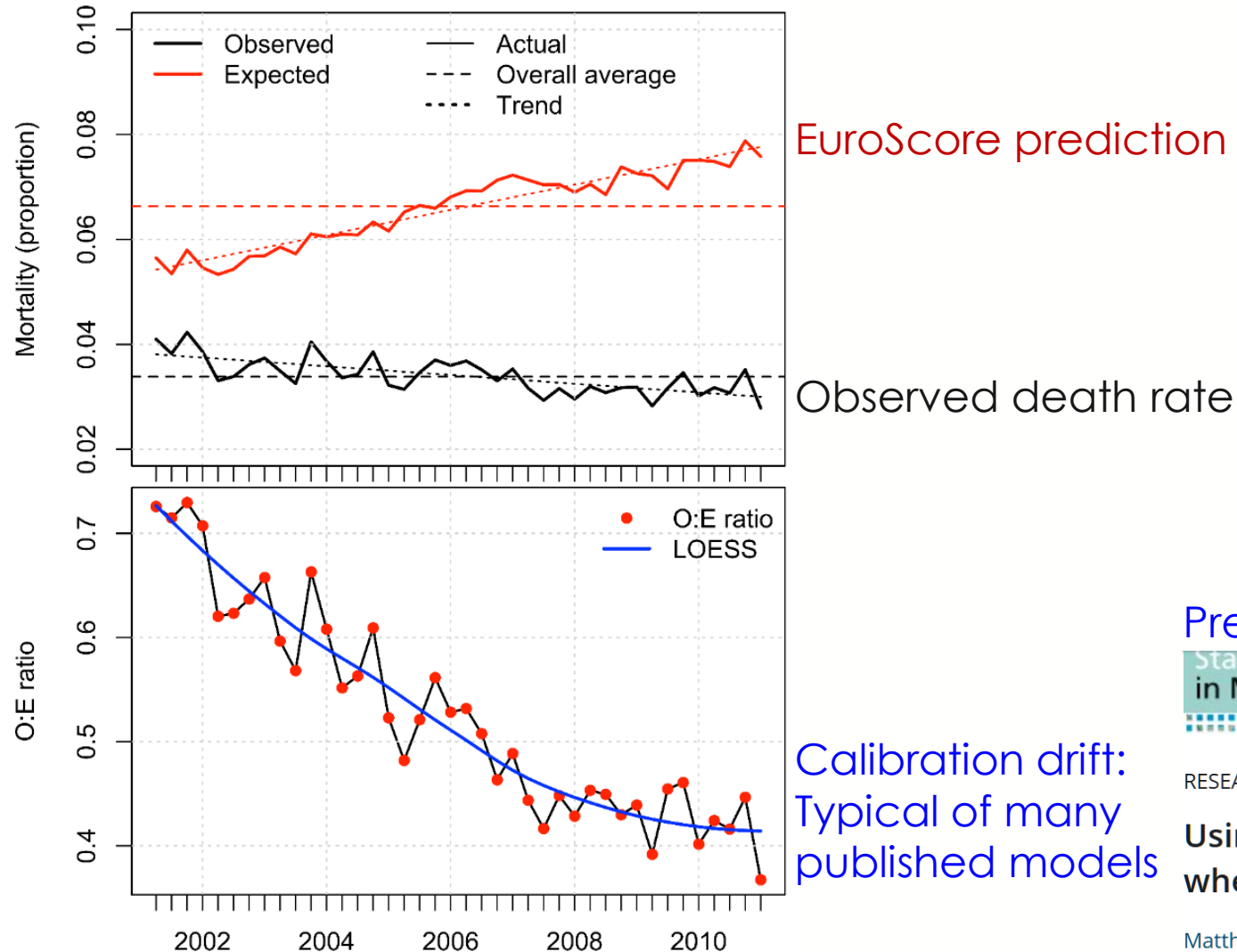
Blood sugar control

**<1/3 outcomes explained by evidence**

Valderas JM, Starfield B, Sibbald B, Salisbury C, Roland M. Defining comorbidity: implications for understanding health and health services. Ann. Fam. 2009;7:357-363.



# Market Failure: Models to Predict Better Care



Academia rewards publishing papers on the same topic every 10y or so

Industry has no trusted 3<sup>rd</sup> route for (re)validating algorithms/models

Some models can be learned, and most updated, from data

Prediction with longitudinal-interventions is worse...



RESEARCH ARTICLE | [Open Access](#) |

**Using marginal structural models to adjust for treatment drop-in when developing clinical prediction models**

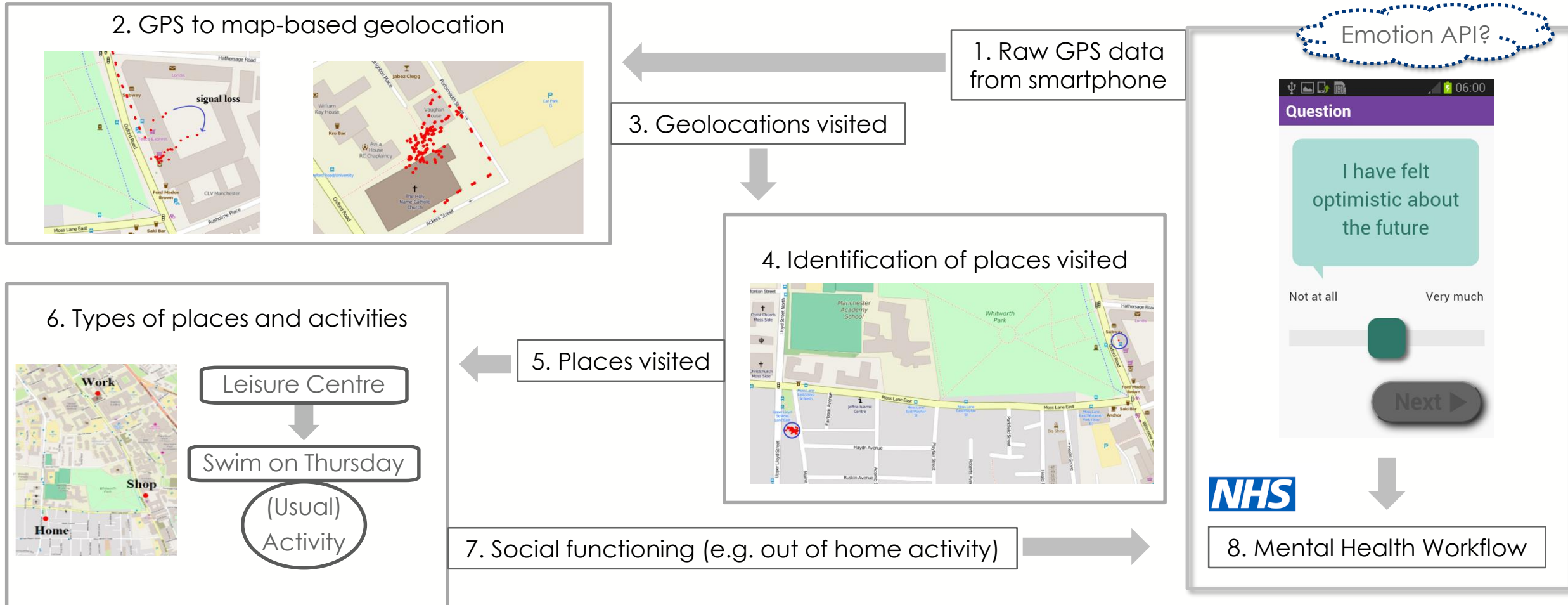
Matthew Sperrin , Glen P. Martin, Alexander Pate, Tjeerd Van Staa, Niels Peek, Iain Buchan

First published: 02 August 2018 | <https://doi.org/10.1002/sim.7913>



# Care from Digital By-products of City Living

**Clinical vs. patient perception of privacy:** sharing location data: patients actively requested



# Civic Data Mandate vs Surveillance Capitalism

Citizen's 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**

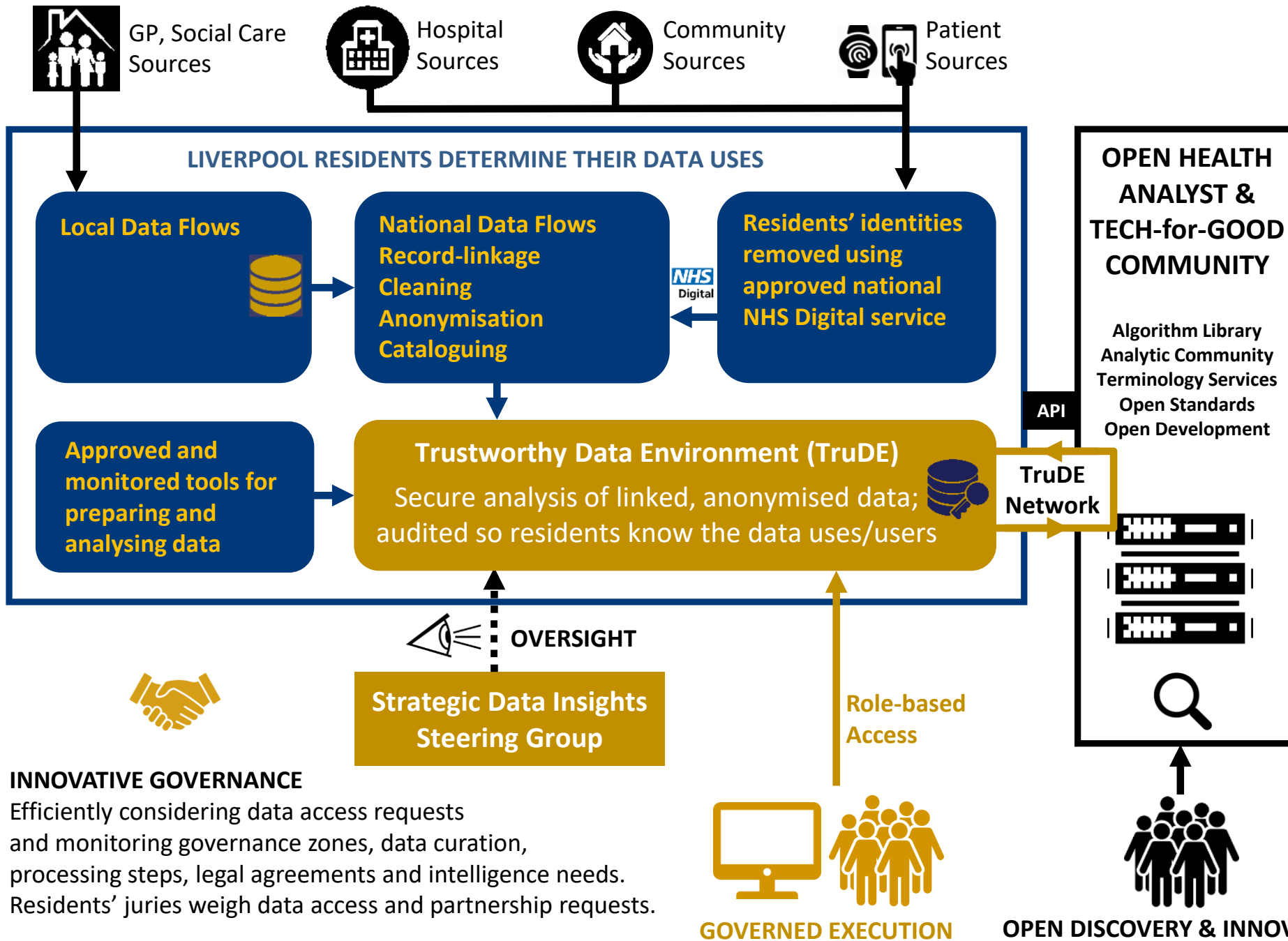


[www.herc.ac.uk/get-involved/citizens-jury/](http://www.herc.ac.uk/get-involved/citizens-jury/)

[www.datasaveslives.info](http://www.datasaveslives.info)

**Citizen/community driven data sharing** accelerating within place-based communities: '**diameters of trust**'

- **Diameter:** large enough for data/analytic/IT economies of scale; small enough to involve the citizenry
- **Small nations:** Denmark, Israel, Scotland, Wales... share **data** and drive **digital** innovation more
- **Discrete systems:** NHS trusts + local authorities drive system **learning**
- **Disruptive citizen:** Future citizen data controller / '**consent concierge**' needs smart city/region API



Civic Data  
Cooperative

One Liverpool  
Trustworthy  
Data  
Environment



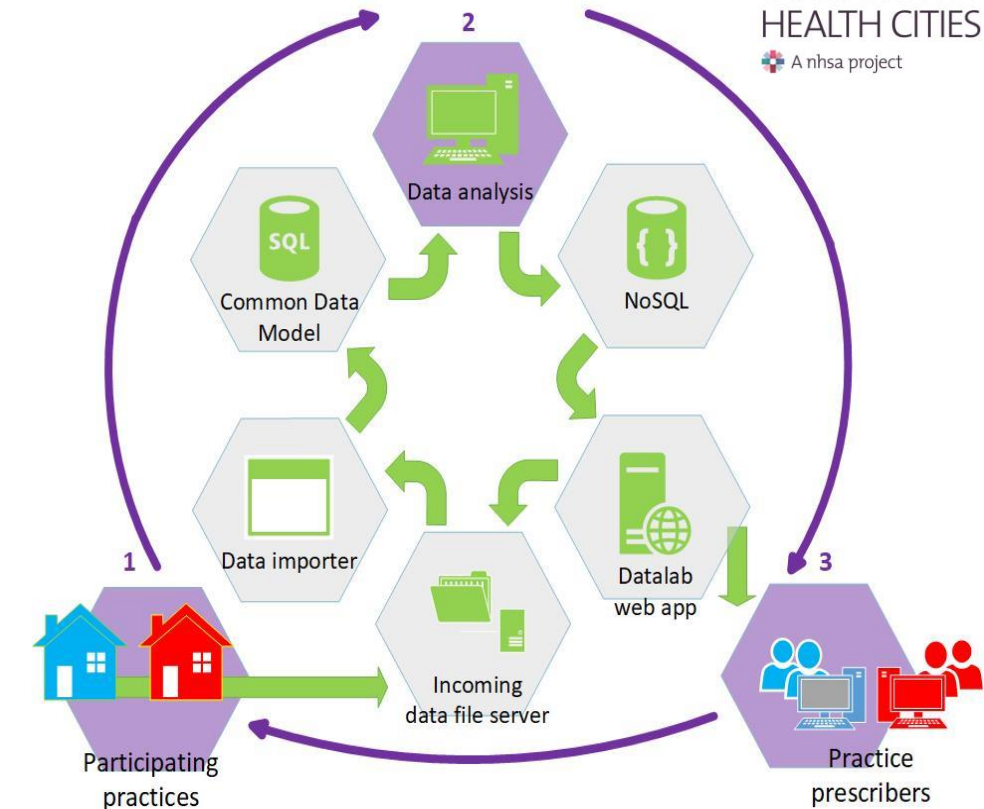
Open Analytic  
& Health Tec  
Innovation



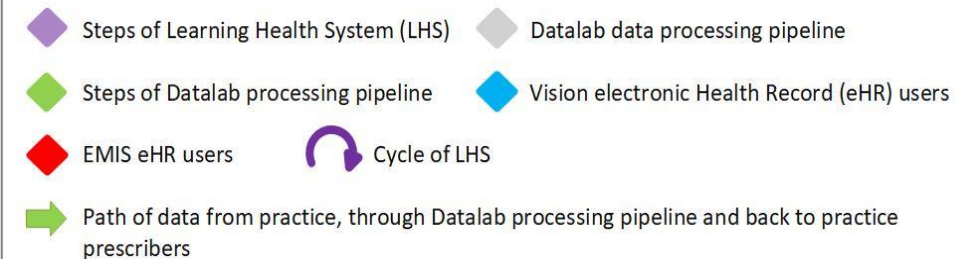


# Tackling an Existential Threat to Humanity

- Problem: rise in drug-resistant bugs; running out of drugs
- Advanced analytics with national and local data from >70 GP practices > 10m patient records in DataLab
- Public involvement: #DataSavesLives
- Feedback to practices in learning loops
- Co-design between scientists, services and patients
- Aim: learn how to nudge prescriber behaviour



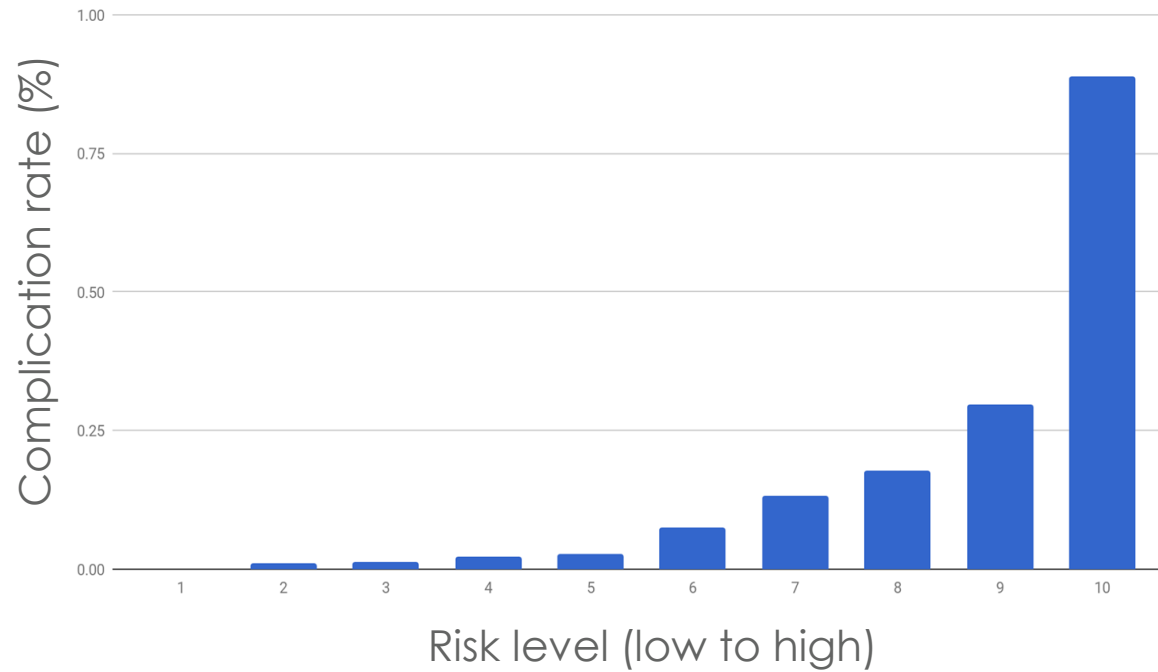
[www.connectedhealthcities.org/  
research-projects/using-data-tackle-antibiotic-resistance/](http://www.connectedhealthcities.org/research-projects/using-data-tackle-antibiotic-resistance/)





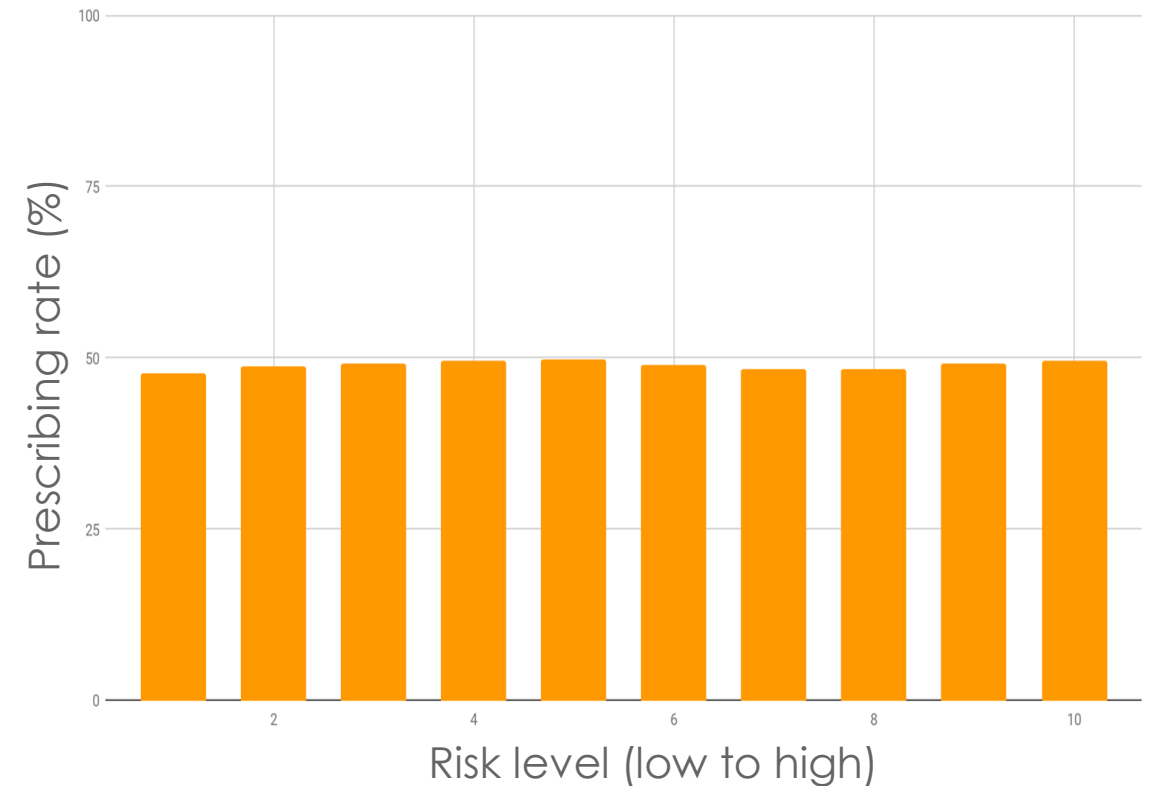
# Antibiotics Not Prescribed Sparingly/Socially

Upper respiratory tract infections: complications vs risk  
(HES outcome 119)



Large variation in risk of hospital admission  
for upper respiratory tract infection  
computed from GP and hospital records

Upper respiratory tract infections: prescribing vs. risk

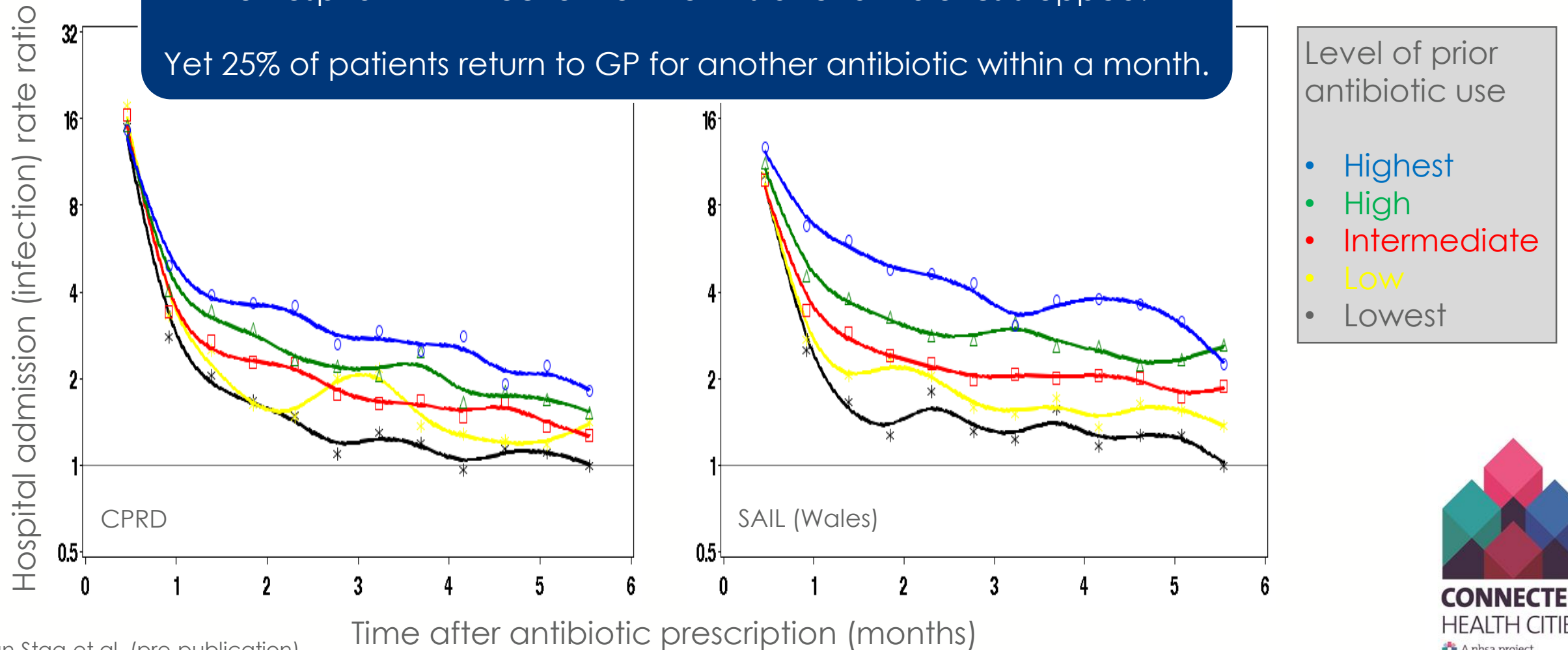


Antibiotic prescribing unrelated to risk

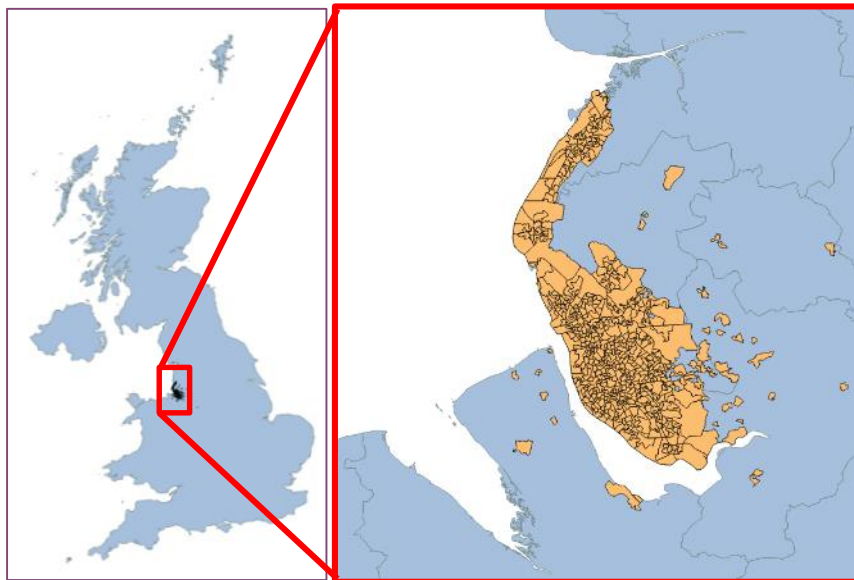
# Repeat Antibiotics are Frequent but Ineffective

Patients with more prior antibiotic use were more likely to be admitted to hospital with infection for months after antibiotics stopped.

Yet 25% of patients return to GP for another antibiotic within a month.



# Co-surveillance of GP and Vet Prescribing



## Medical data

- Liverpool CCG facilitation.
- June 2014 – May 2016.
- 26 general practices.
- Anonymised EHRs.
- Sex, aggregated age.
- Residence (LSOA ~ 1500 people).
- Antibiotic product codes.



## Small animal data

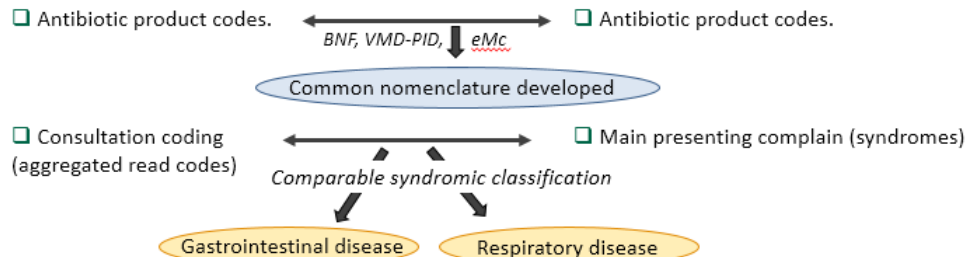
- SAVSNET data.
- April 2014 – March 2016.
- 37 veterinary practices (52 sites).
- Species (i.e. dogs and cats).
- Sex, aggregated age, breed.
- Owner's postcode (aggregated to LSOA).
- Antibiotic product codes.



D. Singleton



F. Sánchez-Vizcaíno



Prescription type	Human (% , 95% CI)	Dog (% , 95% CI)	Cat (% , 95% CI)
Most commonly prescribed antibacterial CLASS	Beta-lactam (53.8, 53.6-54.0)	Beta-lactam (48.4, 47.4-49.4)	Beta-lactam (77.1, 74.0-79.9)
Most commonly prescribed antibacterial SUBSTANCE	Amoxicillin (30.7, 30.4-30.9)	CAPA (28.4, 27.5-29.2)	3 <sup>rd</sup> Gen. cephalosporin (37.9, 34.5-41.4)
Percentage of prescriptions that were HPCIA	(14.9, 14.7-15.0)	(6.8, 6.3-7.3)	(41.0, 37.6-44.5)
Most commonly prescribed HPCIA	Macrolide (89.1, 88.7-89.5)	Fluoroquinolone (88.0, 85.4-90.2)	3 <sup>rd</sup> Gen. cephalosporin (92.4, 89.0-94.9)

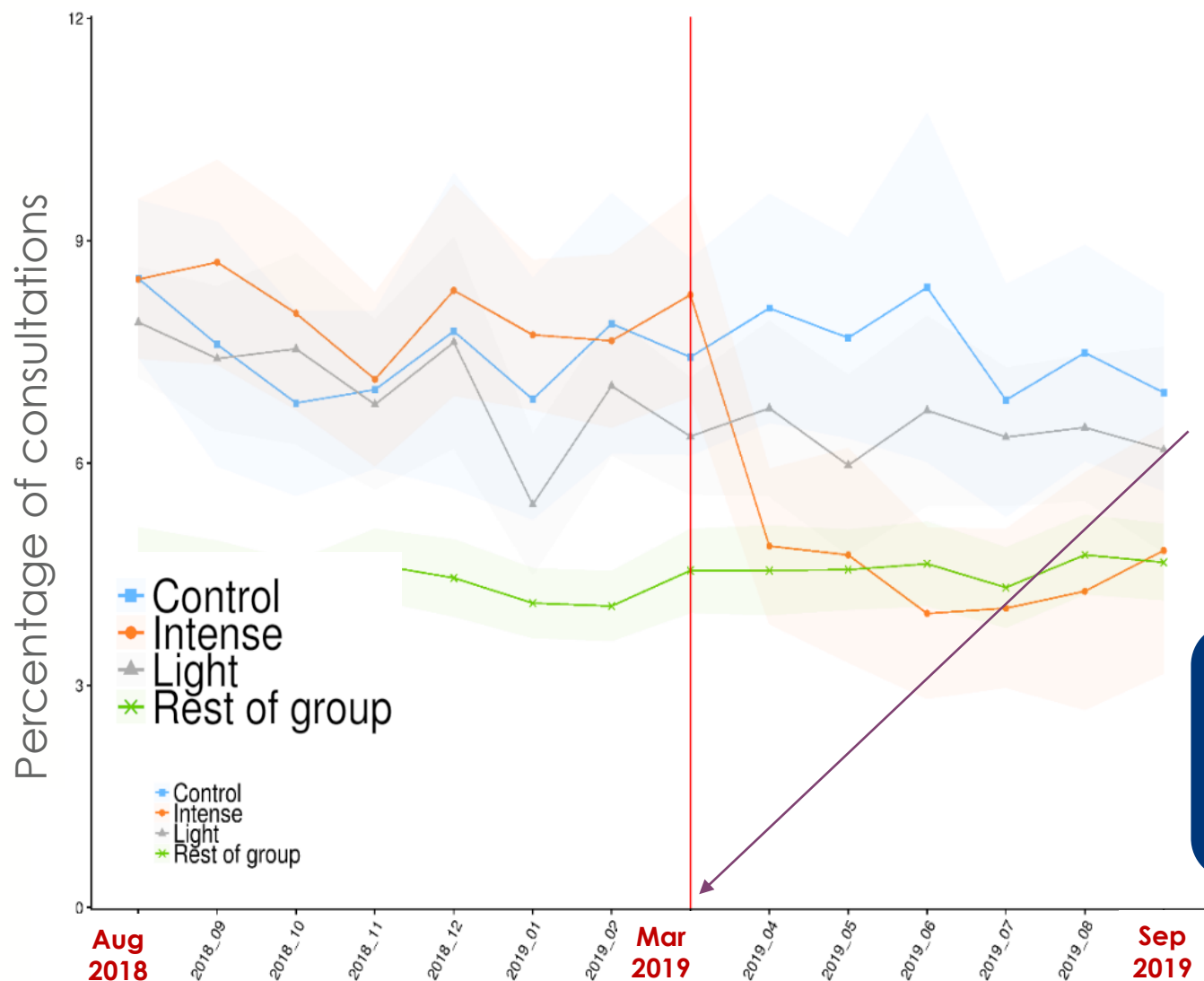
Antibiotic prescription percentage	Human (95% CI)	Dog (95% CI)	Cat (95% CI)
Consultation level	4.3% (4.27-4.31)	23.0% (22.6-23.4)	21.4% (20.7-22.1)
Gastrointestinal disease level	4.2% (4.0-4.4)	43.1% (40.7-45.5)	29.2% (24.8-34.0)
Respiratory disease level	<b>33.0%</b> (32.7-33.2)	41.8% (38.0-45.6)	42.3% (36.9-48.0)
Patient level	<b>39.3%</b> (39.1-39.6)	35.3% (34.5-36.0)	27.1% (26.0-28.2)



[www.savsnet.co.uk](http://www.savsnet.co.uk)

HPCIA: High Priority Clinically Important Antimicrobials

# Vet Feedback Reduced Antibiotic Prescribing



## Practices:

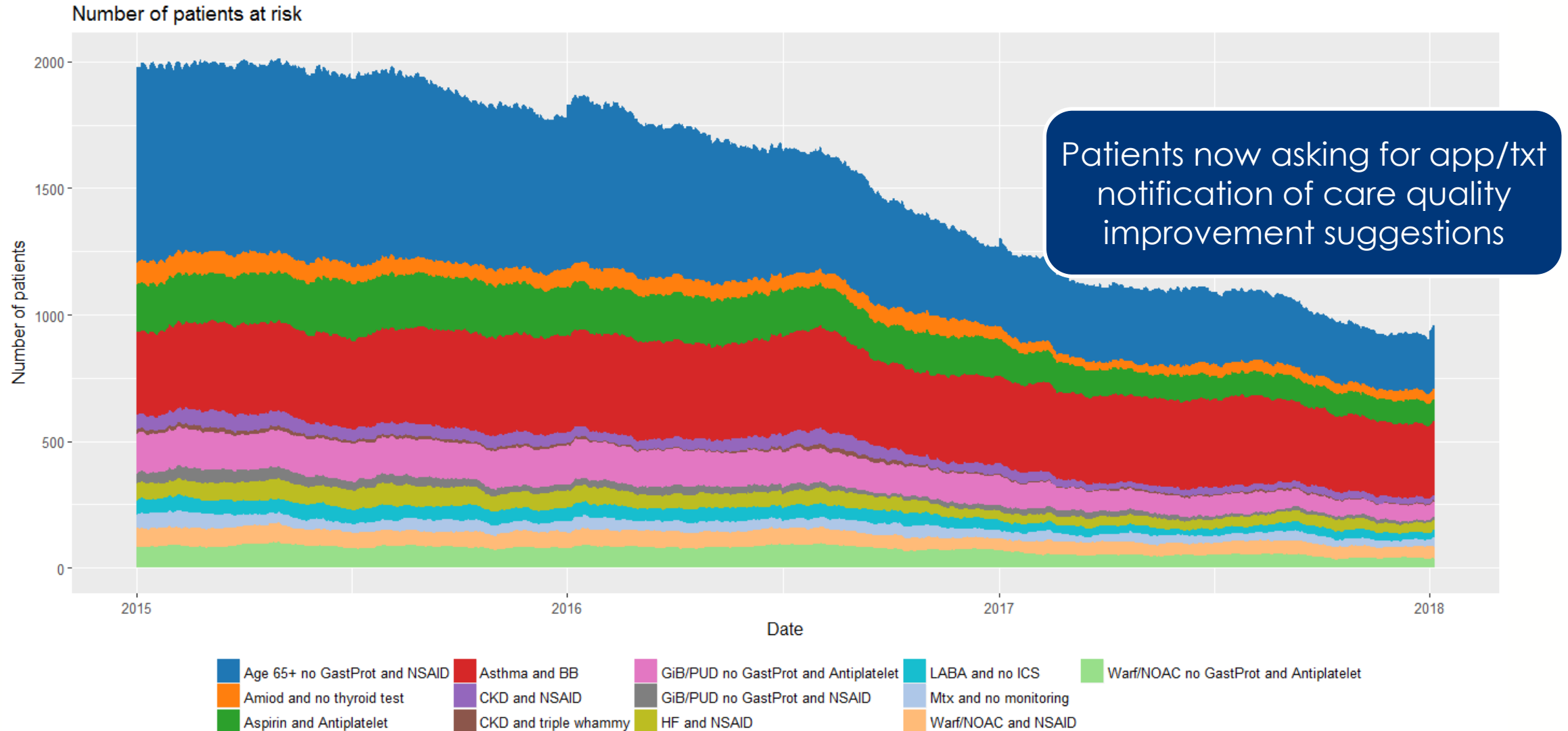
- identified as high users
- given practice profile of antibiotic use
- given two practice visits/discussions

40% decrease in Highest Priority Clinically Important Antimicrobial (HPCIA) use in cats

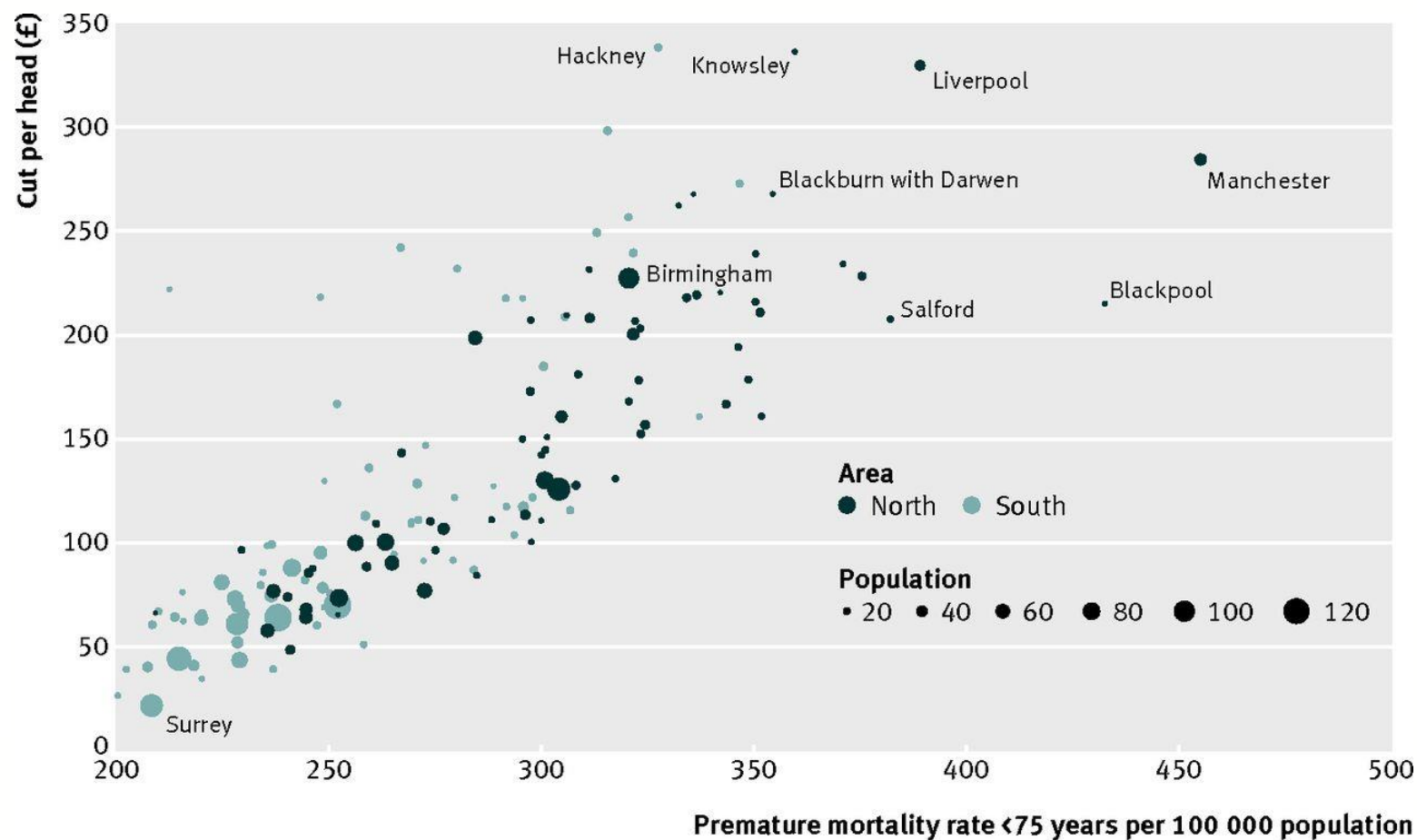
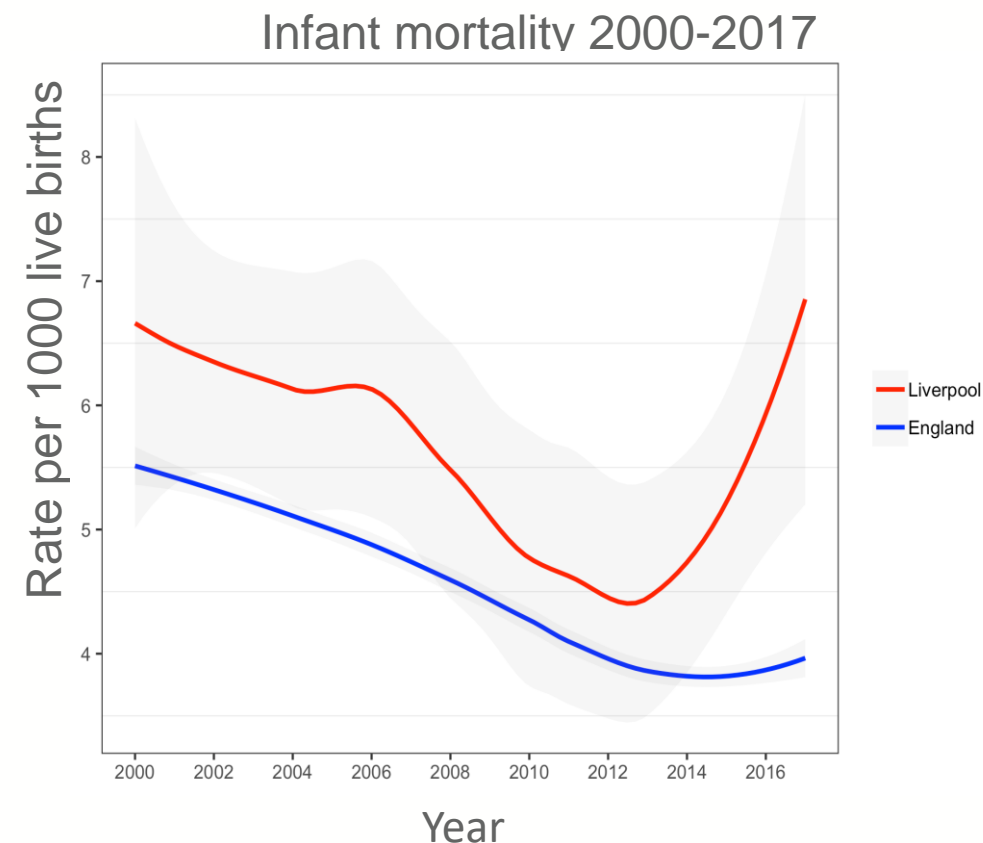
4.4% (95% CI 3.4-5.5) vs. 7.5% (6.1-9.0)



# GP Feedback Halved Medication Safety Issues



# Profound Civic Health Innovation Pressures



Population health time-bomb:  
begs innovation in health and social care, and economic growth

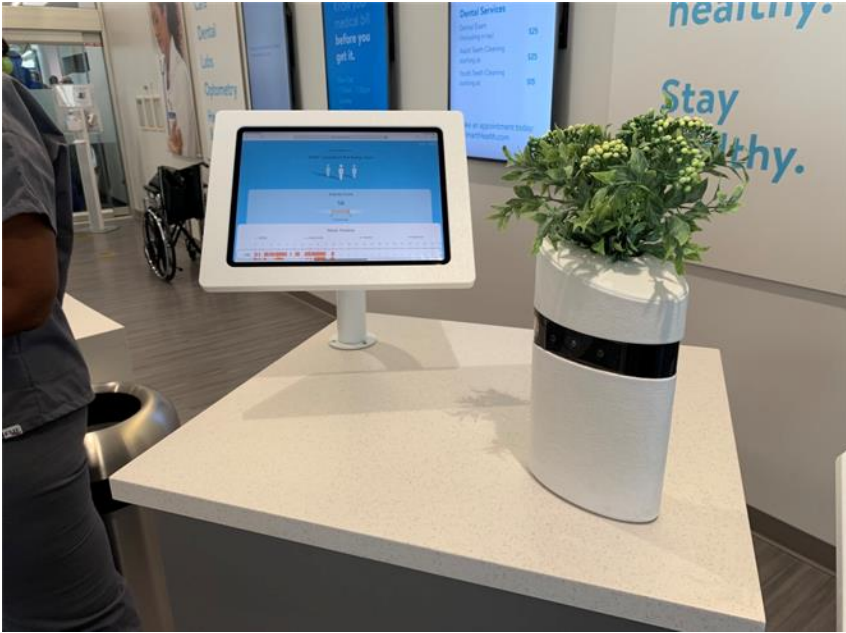
Taylor-Robinson et al. BMJ 2013;347:f4208

# Needs Must: Tech-for-Good in Liverpool

- Must
  - Replace land-line bound tech by 2025
  - Control care costs from frailty & multimorbidity
- Backdrop
  - 40% cuts to LA: 3500 social care workers
  - Highest disease burden and inequalities
  - Fibre to lamp-posts
- Action
  - LA & CCG partner with SMEs and academics on DCMS-supported self-build 5G in Kensington
  - Community pharmacists connect daily
  - Recycle unused blister packs
- Result
  - Prescribing costs down and adherence up
  - Social isolation and inequalities reduced



# Health Tech Attracted to Civic Cooperative



- Cherish Health's new RF-based imaging and AI
  - Heart rate and respiratory rate within 7m
  - Falls and ADL-change detection through walls
  - Identify individuals
  - Gait and subtle movement change
  - Temperature, noise, night-time breath sounds
  - \$25 patch for ECG, temp etc
  - Voice interaction
  - Emotion sensing
  - Data-processed on device not cloud
  - <\$165 to manufacture
- Why Liverpool?
  - Data-linked for Telecare
  - Primary-secondary-social care integration
  - Health tech and data science strategy
  - Pragmatic, needs-led culture

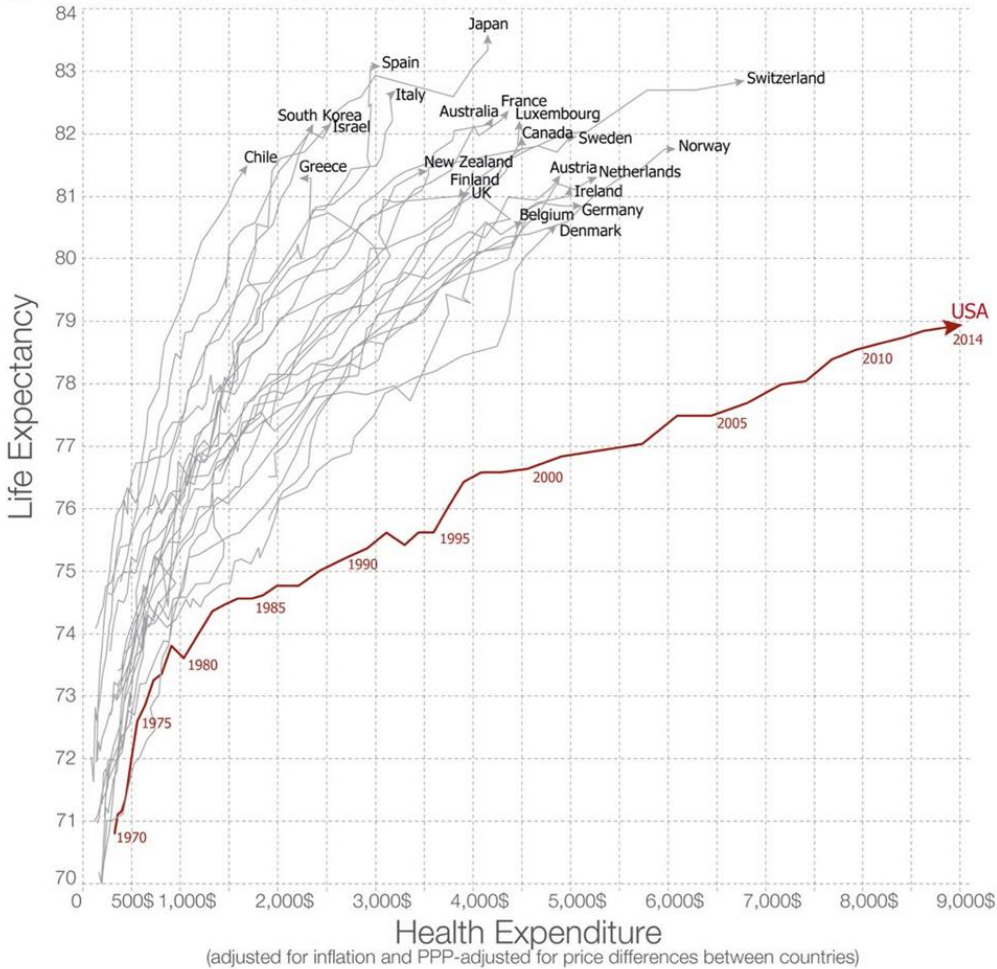




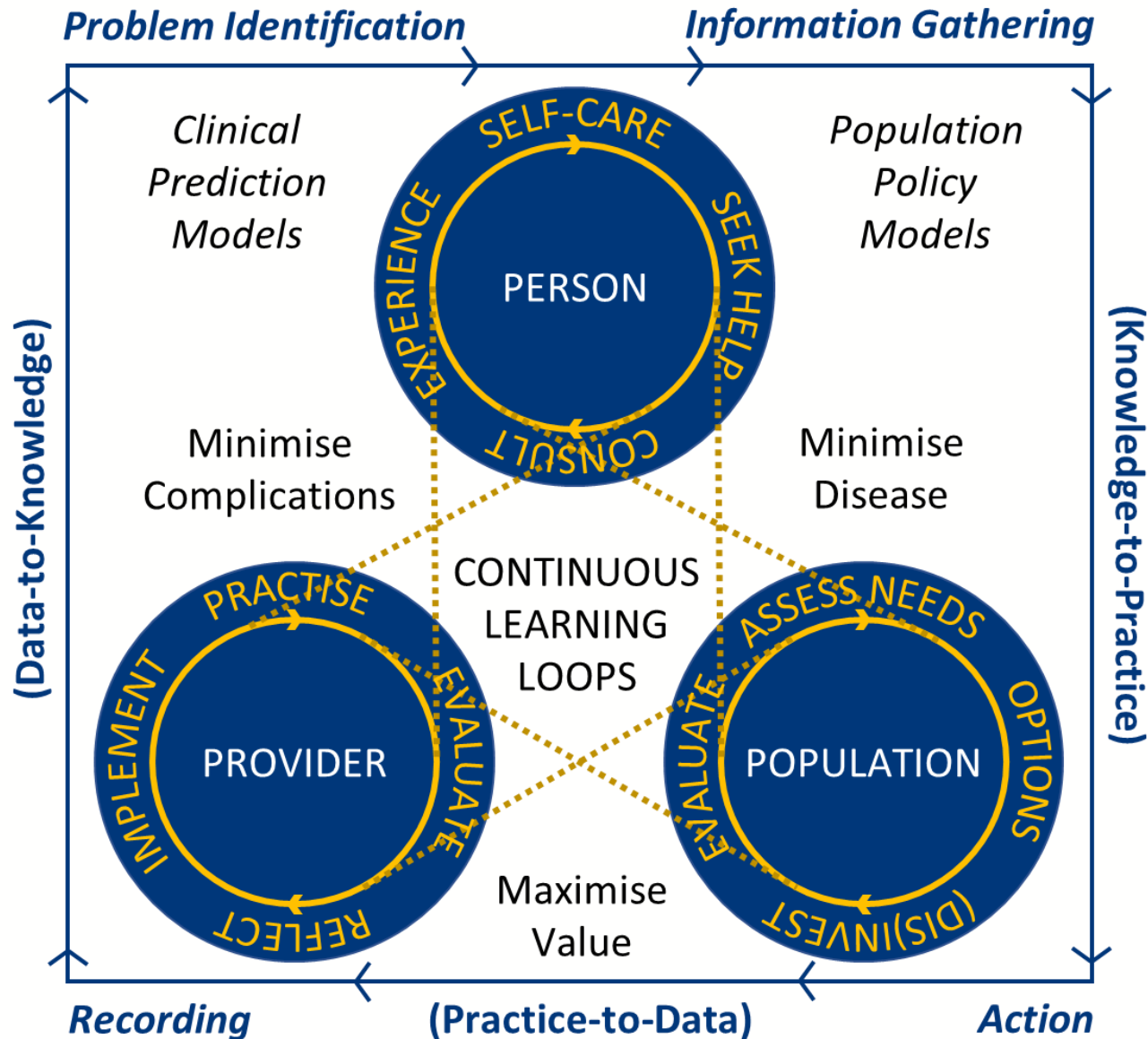
# Smarter Health Cities/Nations: Value Engine

Life expectancy vs. health expenditure over time (1970-2014) 

Health spending measures the consumption of health care goods and services, including personal health care (curative care, rehabilitative care, long-term care, ancillary services and medical goods) and collective services (prevention and public health services as well as health administration), but excluding spending on investments. Shown is total health expenditure (financed by public and private sources).



Data source: Health expenditure from the OECD; Life expectancy from the World Bank. Licensed under CC-BY-SA by the author Max Roser. The interactive data visualization is available at [OurWorldinData.org](https://ourworldindata.org). There you find the raw data and more visualizations on this topic.



# From Surveillance Capitalism to #DataSavesLives

## Closed Uncooperative Innovation?



The Telegraph

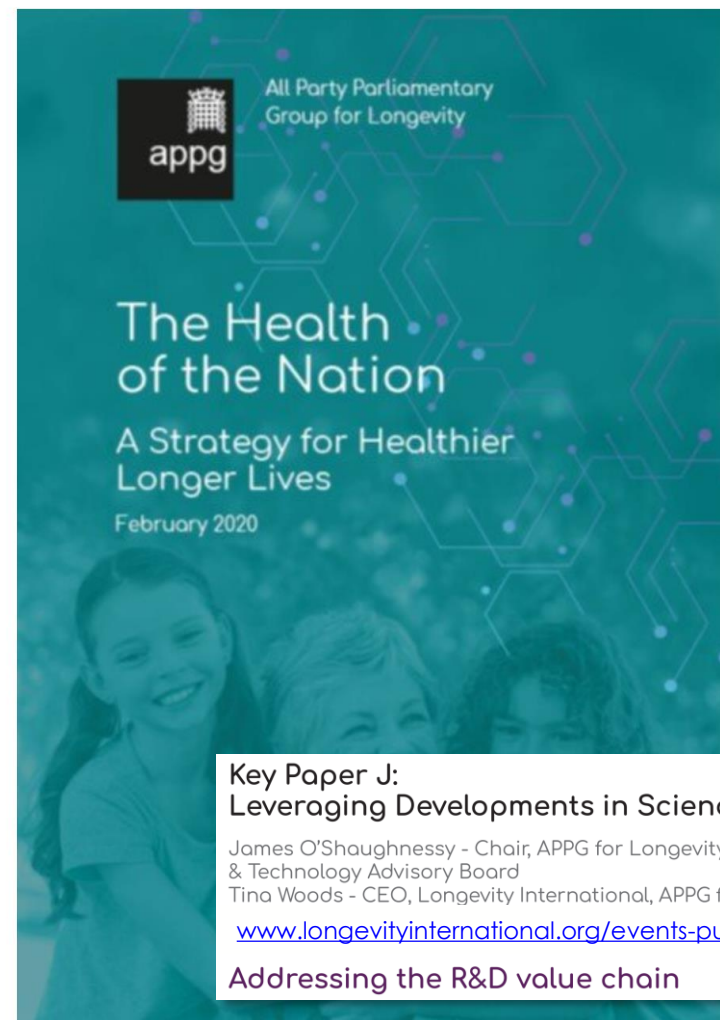
**Revealed: NHS England bosses meet with tech and pharmaceutical giants to discuss price list of millions of Brits' medical data**

Nine 'commercial models' to access central database mulled at hush-hush meeting

By Paul Kunert, UK editor 12 Dec 2019 at 06:06

193 SHARE

**The seismic NHS data goldmine being targeted by tech giants like Google**



Cross-Party Call  
for Open Health  
Innovation  
Cooperatives  
Inclusive of  
People, Places  
and Preferences

Public Health  
Imperative