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# The Wearable Clinic

**Niels Peek**

Health e-Research Centre

The University of Manchester

#WearClin

The Wearable Clinic Launch Event, 5th July 2017

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# The Wearable Clinic: Overview

- Consortium
  - University of Manchester
    - Health eResearch Centre (Health Sciences)
    - Sensing, Imaging and Signal Processing (EEE)
    - Information Management (Computer Science)
    - Psychology & Mental Health (Health Sciences)
  - University of York
    - Centre for Health Economics
    - Department of Computer Science
- Partners Health Innovation Manchester, NHS Digital, Cerner, Withings, PatientView, NICE, Greater Manchester Connected Health Ecosystem, SmartLife
- Funding EPSRC Engineering and Physical Sciences Research Council

# Today's programme (1)

| | | |
|---|---|---|
| 12.00 - 13.00 | **Arrival, registration and buffet lunch** | |
| 13.00 - 13.20 | Introduction to the Wearable Clinic | Niels Peek |
| 13.20 - 13.40 | WS1: Adaptive sensing and behavioural phenotyping | Alex Casson |
| 13.40 - 14.00 | WS2: Dynamic, multi-dimensional risk prediction | Matthew Sperrin |
| 14.00 - 14.15 | Patient involvement and engagement | Lamiece Hassan |
| 14.15 - 14.30 | Risk analysis and assurance case | Ibrahim Habli |
| 14.30 - 15.00 | **Coffee** | |

# Today's programme (2)

| | | |
|---|---|---|
| 15.00 - 15.15 | Health economics of the Wearable Clinic | Cynthia Iglesias |
| 15.15 - 15.30 | Geolocation data in serious mental illness phenotyping | Paolo Fraccaro & Stuart Lavery-Blackie |
| 15.30 - 15.50 | WS3: Data-responsive care planning | Bijan Parsia |
| 15.50 - 16.30 | Breakout session | All |
| 16.30 - 16.45 | Feedback on breakout session | |
| 16.45 - 17.00 | Closing remarks | |
| 17.00 onwards | **Drinks and networking** | |

# Menu

Background

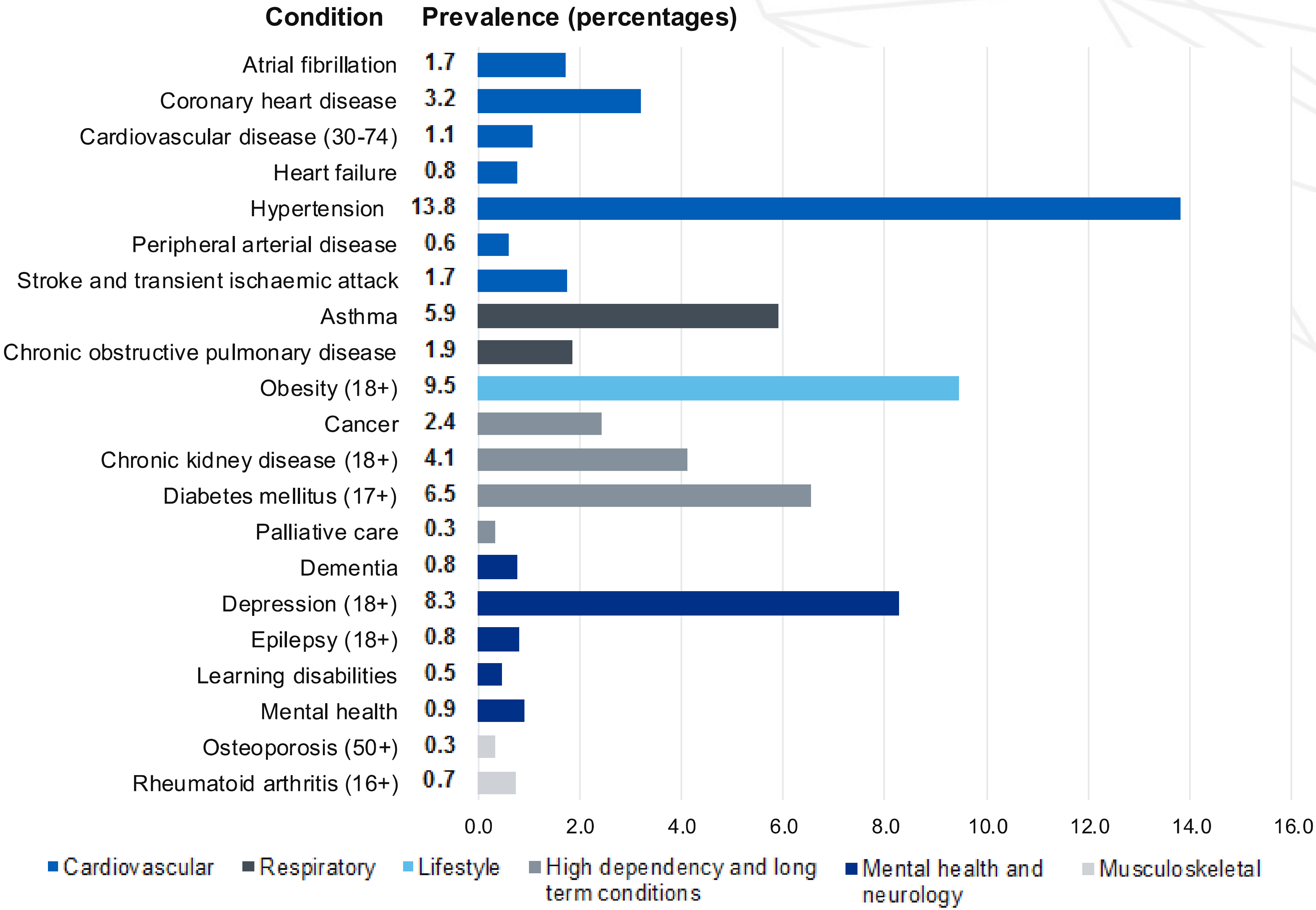
Vision

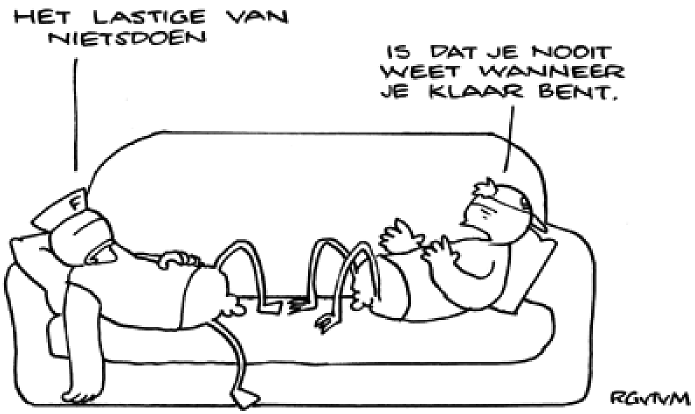
Research programme

Clinical exemplars

Preliminary work

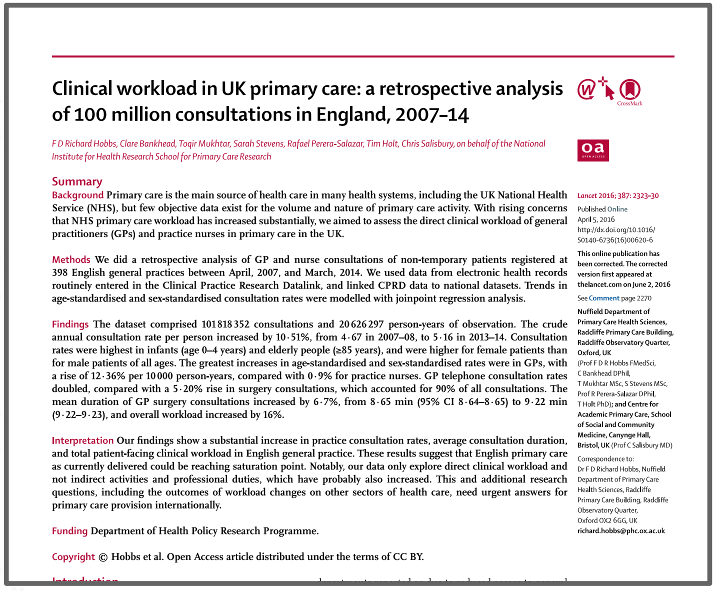
England, 2015-16











# Clinical workload in UK primary care: a retrospective analysis of 100 million consultations in England, 2007–14

F D Richard Hobbs, Clare Bankhead, Toqir Mukhtar, Sarah Stevens, Rafael Perera-Salazar, Tim Holt, Chris Salisbury, on behalf of the National Institute for Health Research School for Primary Care Research

**Summary**

**Background** Primary care is the main source of health care in many health systems, including the UK National Health Service (NHS), but few objective data exist for the volume and nature of primary care activity. With rising concerns that NHS primary care workload has increased substantially, we aimed to assess the direct clinical workload of general practitioners (GPs) and practice nurses in primary care in the UK.

**Methods** We did a retrospective analysis of GP and nurse consultations of non-temporary patients registered at 398 English general practices between April, 2007, and March, 2014. We used data from electronic health records routinely entered in the Clinical Practice Research Datalink, and linked CPRD data to national datasets. Trends in age-standardised and sex-standardised consultation rates were modelled with joinpoint regression analysis.

**Findings** The dataset comprised 101 818 352 consultations and 20 626 297 person-years of observation. The crude annual consultation rate per person increased by 10·51%, from 4·67 in 2007–08, to 5·16 in 2013–14. Consultation rates were highest in infants (age 0–4 years) and elderly people (≥85 years), and were higher for female patients than for male patients of all ages. The greatest increases in age-standardised and sex-standardised rates were in GPs, with a rise of 12·36% per 10 000 person-years, compared with 0·9% for practice nurses. GP telephone consultation rates doubled, compared with a 5·20% rise in surgery consultations, which accounted for 90% of all consultations. The mean duration of GP surgery consultations increased by 6·7%, from 8·65 min (95% CI 8·64–8·65) to 9·22 min (9·22–9·23), and overall workload increased by 16%.

**Interpretation** Our findings show a substantial increase in practice consultation rates, average consultation duration, and total patient-facing clinical workload in English general practice. These results suggest that English primary care as currently delivered could be reaching saturation point. Notably, our data only explore direct clinical workload and not indirect activities and professional duties, which have probably also increased. This and additional research questions, including the outcomes of workload changes on other sectors of health care, need urgent answers for primary care provision internationally.

**Funding** Department of Health Policy Research Programme.



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This online publication has been corrected. The corrected version first appeared at thelancet.com on June 2, 2016

See Comment page 2270

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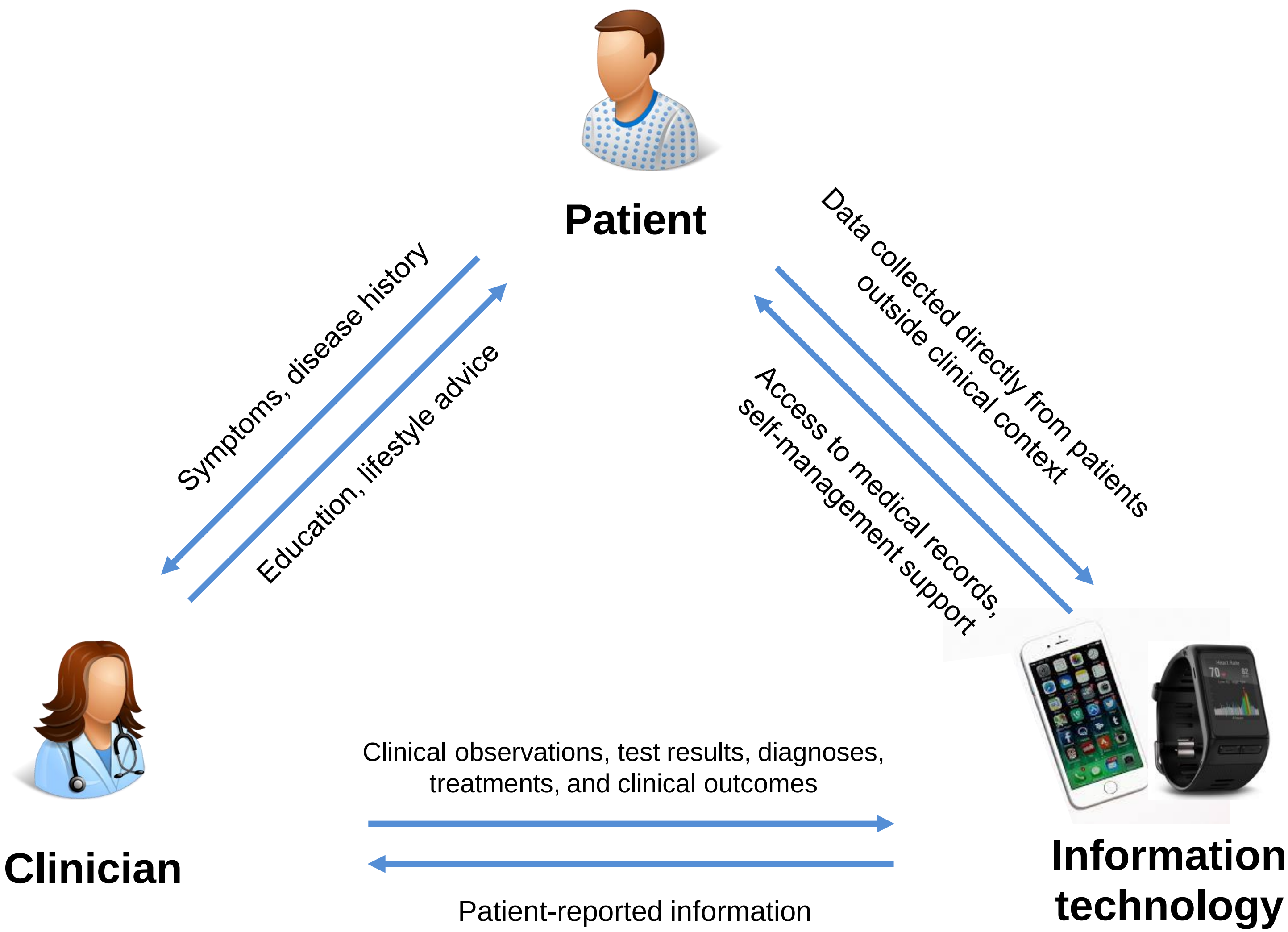
**richard.hobbs@phc.ox.ac.uk**

# Trends in computing

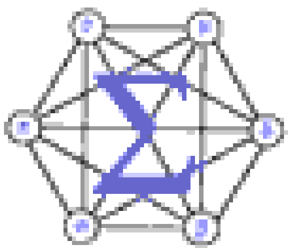
- Ubiquity: computers are everywhere
- Interconnection, e.g. internet
- Intelligence: the complexity of tasks that computers can do grows steadily
- Delegation: we are giving more control to computers
- Human orientation, e.g. smart watches

# Vision for The Wearable Clinic



# Challenges

limitations in battery life impede wearable sensors, narrowing the scope of applications

existing clinical risk prediction methods are inadequate for the dynamic complexity of long-term conditions

electronic guideline systems not suited for long-term care with complex interactions

a large number of new technologies do not translate to clinical practice

# Research programme

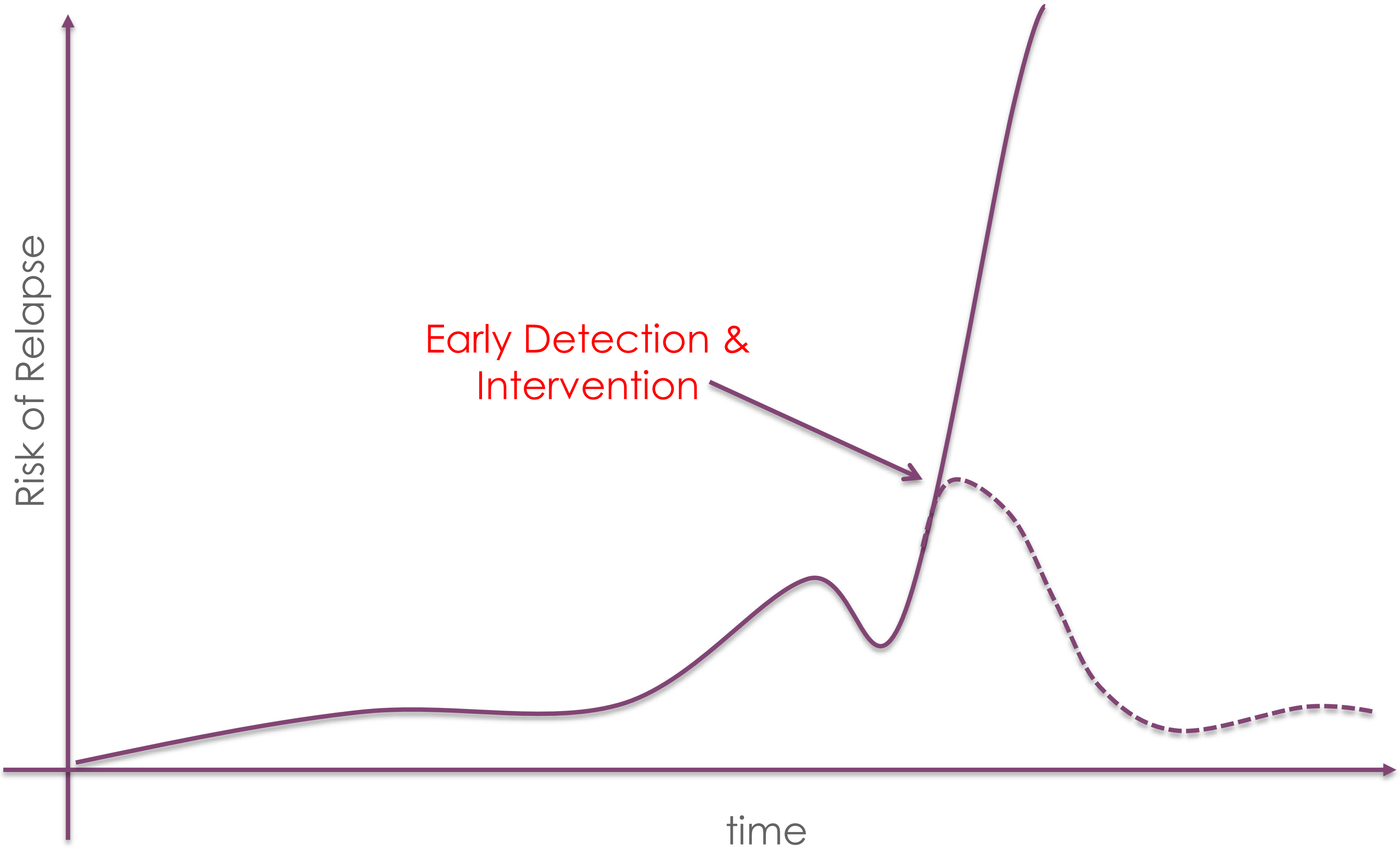
1. Design adaptive sensing and signal compression algorithms for high-resolution sensing data
2. Dynamic multidimensional methods for predicting health risks
3. Create algorithms for adaptive, personalised care planning for patients with long-term conditions
4. Support future real-world deployment of The Wearable Clinic through early assessment of:
    - preferences of patients and their carers
    - potential health and economic benefits
    - patient safety and data security risks
    - regulatory challenges associated with clinical deployment

# Closing the translational gap

The Farr Institute of Health Informatics Research

# Clinical examplars

- Schizophrenia
  - common, long-term mental health condition
  - sudden episodes of psychosis involving hallucinations, delusions, and changes in behaviour
  - psychosis often results in unscheduled hospital admission, with substantial suffering as well as high healthcare costs
- Chronic kidney disease
  - progressive decline in kidney function over time
  - patients often have one or more other long-term conditions (such as diabetes or heart disease)
  - high risk of developing acute kidney injury, an abrupt loss of kidney function that often requires hospital admission

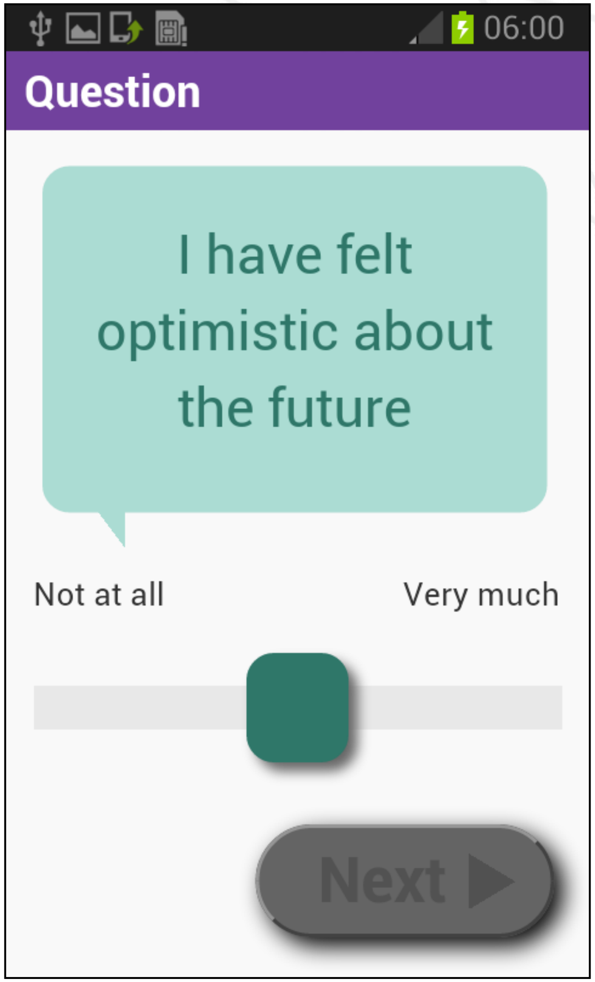

Risk of Relapse
Early Detection &
Intervention
time

# Preliminary work

- Schizophrenia
  - ClinTouch
  - CareLoop
  - digital phenotyping
- Chronic kidney disease
  - onset prediction
  - PatientView

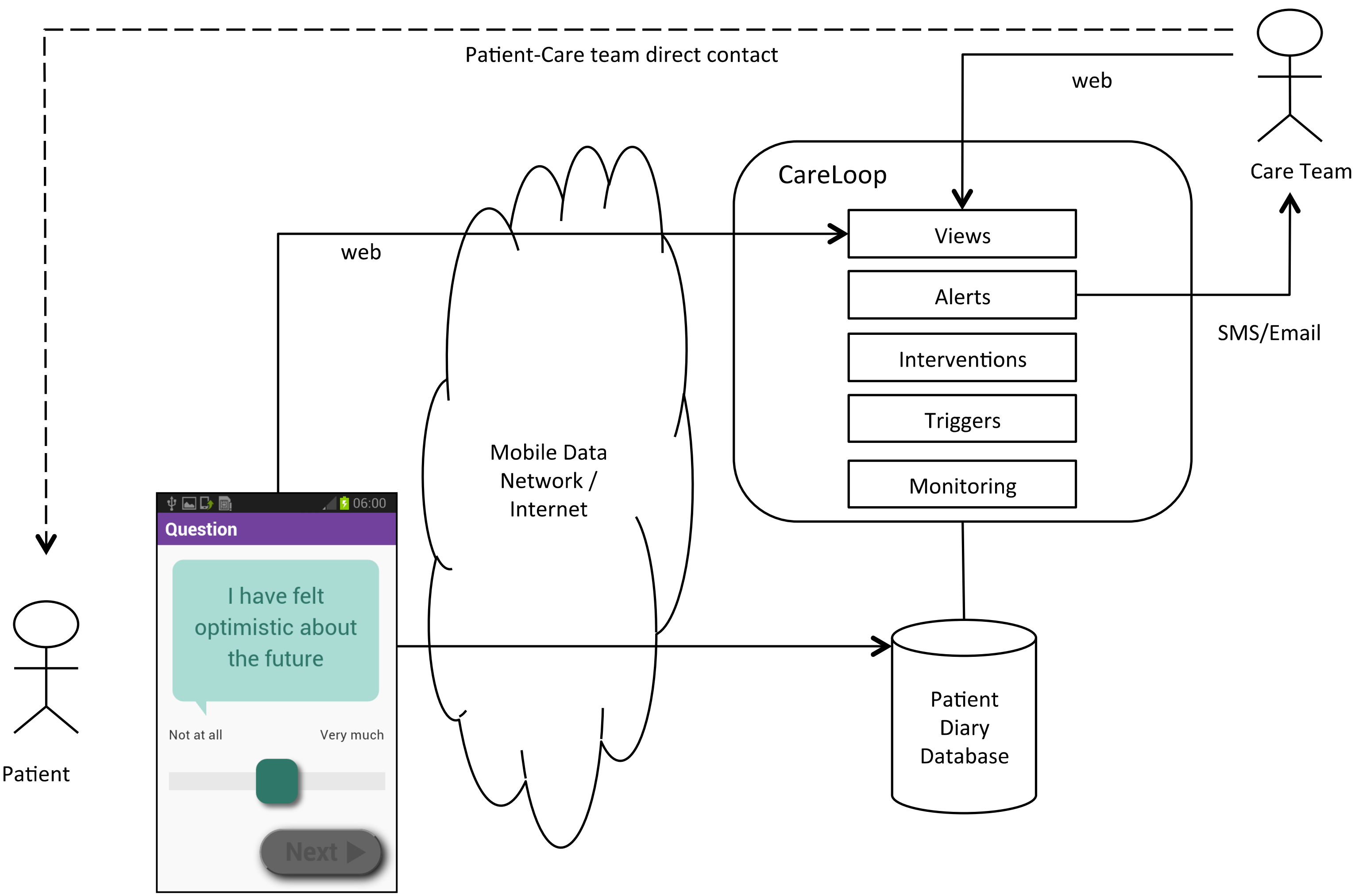
# ClinTouch – Mobile monitoring for schizophrenia

- Experience sampling methodology
- User responds on a touch-screen mobile phone
- Validated against the Positive and Negative Syndrome Scale (PANSS) for measuring symptom severity in schizophrenia




http://www.clintouch.com

# CareLoop



Patient-Care team direct contact
web
Care Team
CareLoop
web
Views
Alerts
Interventions
Triggers
Monitoring
SMS/Email
Mobile Data
Network /
Internet
06:00
Question
I have felt optimistic about the future
Not at all
Very much
Next
Patient
Patient
Diary
Database

# CareLoop clinician interface

https://dev.careloop.org.uk/clintouch/#/providers/1/myparticipants

ClinTouch

Test Provider Log out

PROVIDER MENU

My participants

All participants

## My Participants

Search | Order by Status

Add participant

| Username | Name | Mobile | NHS No | Ext Id | Date of Birth | Status | Provider | | |
|---|---|---|---|---|---|---|---|---|---|
| DawnNorris | Ms Dawn Q Norris | 07891 864401 | 4852337554 | GGI01033897 | 1983-11-07 | INTERVENE | TestProvider | edit | summary |
| DerekBenson | Ms Derek X Benson | 07891 138548 | 4021083012 | CIR69280419 | 1945-11-05 | INTERVENE | TestProvider | edit | summary |
| LaceyBeck | Mrs Lacey K Beck | 07891 947774 | 5463864380 | SYF12838032 | 1927-09-14 | MONITOR | TestProvider | edit | summary |
| CarolPhillips | Mrs Carol H Phillips | 07891 081501 | 7516426149 | XBR80958949 | 1928-06-03 | MONITOR | TestProvider | edit | summary |
| AmayaMendez | Mrs Amaya O Mendez | 07891 858650 | 8009330236 | WQW04623471 | 1933-11-10 | MONITOR | TestProvider | edit | summary |
| MargaretCarrillo | Mr Margaret G Carrillo | 07891 515212 | 5380868330 | MAF00635150 | 1931-06-05 | MONITOR | TestProvider | edit | summary |
| TestParticipant | Mrs Test H Participant | 07891 666072 | 2736840145 | LKA68256122 | 1997-11-30 | OK | TestProvider | edit | summary |
| VictoriaKlein | Mr Victoria N Klein | 07891 313494 | 8322800095 | OQN65093317 | 1925-08-13 | OK | TestProvider | edit | summary |
| GarrisonScott | Ms Garrison J Scott | 07891 128345 | 5824176919 | ULV28783802 | 1940-08-29 | OK | TestProvider | edit | summary |
| WyattHancock | Mr Wyatt I Hancock | 07891 587901 | 0508568851 | GBU16439917 | 1929-04-07 | OK | TestProvider | edit | summary |
| RooneyHolder | Mrs Rooney H Holder | 07891 208044 | 2729115697 | BEF70504702 | 1932-06-14 | OK | TestProvider | edit | summary |
| LeslieMcdonald | Mrs Leslie L Mcdonald | 07891 333913 | 3365097951 | OUP71607941 | 1976-10-16 | OK | TestProvider | edit | summary |
| BarclayBarr | Mr Barclay U Barr | 07891 887299 | 5184689020 | UIH93614802 | 1959-07-01 | OK | TestProvider | edit | summary |
| DoraRatliff | Ms Dora X Ratliff | 07891 249445 | 1394813542 | HNG71250509 | 1945-05-21 | OK | TestProvider | edit | summary |
| BryarMelton | Mr Bryar N Melton | 07891 100027 | 0900393608 | HOC37217428 | 1991-06-14 | OK | TestProvider | edit | summary |
| JulianBrewer | Dr Julian O Brewer | 07891 039042 | 9351579425 | NQO80863802 | 2000-11-25 | OK | TestProvider | edit | summary |

# Digital phenotyping

**1. Raw GPS data**

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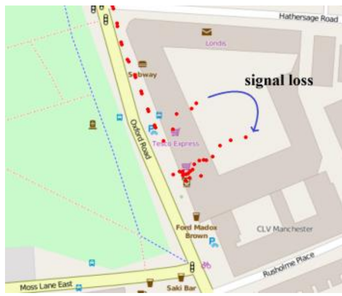
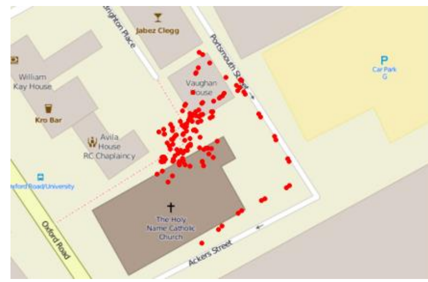
**2. Detection of geolocation visited**

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**3. Geolocations visited**

↓

**4. Identification of places visited**


←

**5. Places visited**

←

**6. Type of places and activities recognition**


Swimming pool → Sport ← Volleyball

→

**7. Out-of-home activities**

Fraccaro *et al. BMC Medicine* (2016) 14:104
DOI 10.1186/s12916-016-0650-2

BMC Medicine

RESEARCH ARTICLE Open Access

# An external validation of models to predict the onset of chronic kidney disease using population-based electronic health records from Salford, UK

Paolo Fraccaro[1,2,3], Sabine van der Veer[2,3], Benjamin Brown[1,2,3], Mattia Prosperi[2,3,4], Donal O'Donoghue[5], Gary S. Collins[6], Iain Buchan[1,2,3] and Niels Peek[1,2,3*]

## Abstract

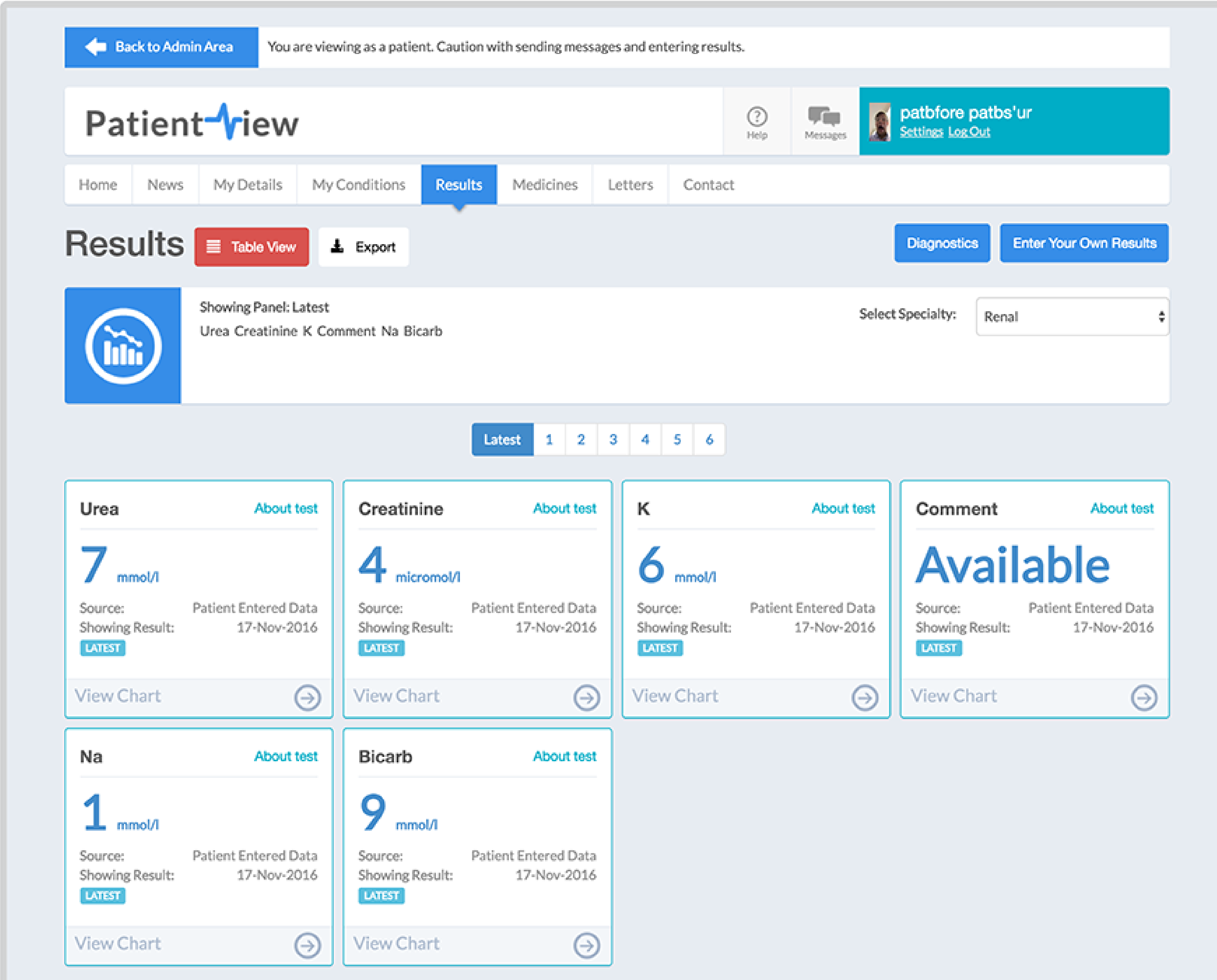
**Background:** Chronic kidney disease (CKD) is a major and increasing constituent of disease burdens worldwide. Early identification of patients at increased risk of developing CKD can guide interventions to slow disease progression, initiate timely referral to appropriate kidney care services, and support targeting of care resources. Risk prediction models can extend laboratory-based CKD screening to earlier stages of disease; however, to date, only a few of them have been externally validated or directly compared outside development populations. Our objective was to validate published CKD prediction models applicable in primary care.

**Methods:** We synthesised two recent systematic reviews of CKD risk prediction models and externally validated selected models for a 5-year horizon of disease onset. We used linked, anonymised, structured (coded) primary and secondary care data from patients resident in Salford (population ~234 k), UK. All adult patients with at least one record in 2009 were followed-up until the end of 2014, death, or CKD onset ($n = 178{,}399$). CKD onset was defined as repeated impaired eGFR measures over a period of at least 3 months, or physician diagnosis of CKD Stage 3–5. For each model, we assessed discrimination, calibration, and decision curve analysis.

**Results:** Seven relevant CKD risk prediction models were identified. Five models also had an associated simplified scoring system. All models discriminated well between patients developing CKD or not, with c-statistics around 0.90. Most of the models were poorly calibrated to our population, substantially over-predicting risk. The two models that did not require recalibration were also the ones that had the best performance in the decision curve analysis.

**Conclusions:** Included CKD prediction models showed good discriminative ability but over-predicted the actual 5-year CKD risk in English primary care patients. QKidney, the only UK-developed model, outperformed the others. Clinical prediction models should be (re)calibrated for their intended uses.

**Keywords:** Chronic kidney disease, Clinical prediction models, eGFR, Decision support, Electronic health records, Model validation, Model calibration


Back to Admin Area
You are viewing as a patient. Caution with sending messages and entering results.
PatientView
Help
Messages
patbfore patbs'ur
Settings Log Out
Home
News
My Details
My Conditions
Results
Medicines
Letters
Contact
Results
Table View
Export
Diagnostics
Enter Your Own Results
Showing Panel: Latest
Urea Creatinine K Comment Na Bicarb
Select Specialty:
Renal
Latest 1 2 3 4 5 6
Urea
About test
7 mmol/l
Source: Patient Entered Data
Showing Result: 17-Nov-2016
LATEST
View Chart
Creatinine
About test
4 micromol/l
Source: Patient Entered Data
Showing Result: 17-Nov-2016
LATEST
View Chart
K
About test
6 mmol/l
Source: Patient Entered Data
Showing Result: 17-Nov-2016
LATEST
View Chart
Comment
About test
Available
Source: Patient Entered Data
Showing Result: 17-Nov-2016
LATEST
View Chart
Na
About test
1 mmol/l
Source: Patient Entered Data
Showing Result: 17-Nov-2016
LATEST
View Chart
Bicarb
About test
9 mmol/l
Source: Patient Entered Data
Showing Result: 17-Nov-2016
LATEST
View Chart

# Summary: The Wearable Clinic

- Growing number of people with long-term conditions, over-burdening the health service
- Ubiquity of information technology in daily life ➔ create a virtual clinic that is "always with you"
- Workstreams
  - wearable sensing
  - dynamic risk prediction
  - adaptive care planning
  - support future real-world deployment
- Two clinical exemplars

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# Thank you


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