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 Launch Event, 5th July 2017
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
Today’s programme (1)

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Presenter</th>
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<tbody>
<tr>
<td>12.00 - 13.00</td>
<td><strong>Arrival, registration and buffet lunch</strong></td>
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<tr>
<td>13.00 - 13.20</td>
<td>Introduction to the Wearable Clinic</td>
<td>Niels Peek</td>
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<tr>
<td>13.20 - 13.40</td>
<td>WS1: Adaptive sensing and behavioural phenotyping</td>
<td>Alex Casson</td>
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<tr>
<td>13.40 - 14.00</td>
<td>WS2: Dynamic, multi-dimensional risk prediction</td>
<td>Matthew Sperrin</td>
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<tr>
<td>14.00 - 14.15</td>
<td>Patient involvement and engagement</td>
<td>Lamiece Hassan</td>
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<tr>
<td>14.15 - 14.30</td>
<td>Risk analysis and assurance case</td>
<td>Ibrahim Habli</td>
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<tr>
<td>14.30 - 15.00</td>
<td><strong>Coffee</strong></td>
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# Today’s programme (2)

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Speaker(s)</th>
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<tbody>
<tr>
<td>15.00 - 15.15</td>
<td>Health economics of the Wearable Clinic</td>
<td>Cynthia Iglesias</td>
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<td>15.15 - 15.30</td>
<td>Geolocation data in serious mental illness phenotyping</td>
<td>Paolo Fraccaro &amp; Stuart Lavery-Blackie</td>
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<td>15.30 - 15.50</td>
<td>WS3: Data-responsive care planning</td>
<td>Bijan Parsia</td>
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<td>15.50 - 16.30</td>
<td>Breakout session</td>
<td>All</td>
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<tr>
<td>16.30 - 16.45</td>
<td>Feedback on breakout session</td>
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<tr>
<td>16.45 - 17.00</td>
<td>Closing remarks</td>
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<td>17.00 onwards</td>
<td>Drinks and networking</td>
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Menu

Background
Vision
Research programme
Clinical exemplars
Preliminary work
<table>
<thead>
<tr>
<th>Condition</th>
<th>Prevalence (percentages)</th>
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<tbody>
<tr>
<td>Atrial fibrillation</td>
<td>1.7</td>
</tr>
<tr>
<td>Coronary heart disease</td>
<td>3.2</td>
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<tr>
<td>Cardiovascular disease (30-74)</td>
<td>1.1</td>
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<tr>
<td>Heart failure</td>
<td>0.8</td>
</tr>
<tr>
<td>Hypertension</td>
<td>13.8</td>
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<tr>
<td>Peripheral arterial disease</td>
<td>0.6</td>
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<tr>
<td>Stroke and transient ischaemic attack</td>
<td>1.7</td>
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<tr>
<td>Asthma</td>
<td>5.9</td>
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<tr>
<td>Chronic obstructive pulmonary disease</td>
<td>1.9</td>
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<tr>
<td>Obesity (18+)</td>
<td>9.5</td>
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<tr>
<td>Cancer</td>
<td>2.4</td>
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<tr>
<td>Chronic kidney disease (18+)</td>
<td>4.1</td>
</tr>
<tr>
<td>Diabetes mellitus (17+)</td>
<td>6.5</td>
</tr>
<tr>
<td>Palliative care</td>
<td>0.3</td>
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<tr>
<td>Dementia</td>
<td>0.8</td>
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<tr>
<td>Depression (18+)</td>
<td>8.3</td>
</tr>
<tr>
<td>Epilepsy (18+)</td>
<td>0.8</td>
</tr>
<tr>
<td>Learning disabilities</td>
<td>0.5</td>
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<tr>
<td>Mental health</td>
<td>0.9</td>
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<tr>
<td>Osteoporosis (50+)</td>
<td>0.3</td>
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<tr>
<td>Rheumatoid arthritis (16+)</td>
<td>0.7</td>
</tr>
</tbody>
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PERIODIC MAINTENANCE INSPECTION RECORD

INSTRUCTION DATE
MONTH YEAR

INSTRUCTION DATE
MONTH YEAR


© Richard Hobbs, Chris Bondwood, Eoghan Whitley, Sarah Dorey, Richard Parson Schaller, Theo Spirt, Chris Selwyn, on behalf of the National Institute for Health Research Clincial Research Facility

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 many 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-transparent patients registered at 208 English general practices between April, 2007, and March, 2010. We used data from electronic health records routinely entered into the Clinical Practice Research Datalink, and linked CPRD data to national datasets. Trends in age-standardized and non-standardized consultation rates were modelled with joinpoint regression analysis.

Findings The dataset comprised 101530432 consultations and 34264279590 patient-years of observation. The crude annual consultation rate per person increased by 2.5% (95% CI 2.4% to 2.6%) from 2007 to 2008. In 2008–10, consultation rates were highest in infants (age 0–4 months) and elderly people (age 85+ years), and were higher for female patients than for male patients of all ages. The greatest increases in age-standardized and non-standardized rates were in GPs, with an increase of 3.3% per 10 000 person-years, compared with 2.0% for practice nurses. GP inpatient consultation rates doubled, compared with a 1.3% rise in surgery consultations, which accounted for 50% of all consultations. The mean duration of GP surgery consultations increased by 1.7% (from 5.4 min in 2007 CI 1.1% to 2.1%) to 5.5 min (95% CI 3.2% to 7.8%) and overall workload increased by 2.0%.

Interpretation Our findings show a substantial increase in practice consultation rates, stronger consultation duration, and total patient-facing clinical workload in English general practice. These results suggest that English primary care is currently delivering a level of care that could be reaching saturation point. Notably, we did not explore direct clinical workload and output-related activity 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 practices internationally.

Funding Department of Health Policy Research Programme.

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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

Clinician

Patient

Clinical observations, test results, diagnoses, treatments, and clinical outcomes

Patient-reported information

Information technology

Data collected directly from patients

Access to medical records, self-management support

Education, lifestyle advice

Symptoms, disease history
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
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
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 clinician interface

## My Participants

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<tr>
<th>Username</th>
<th>Name</th>
<th>Mobile</th>
<th>NHS No</th>
<th>Ext Id</th>
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Digital phenotyping

1. Raw GPS data

2. Detection of geolocation visited

3. Geolocations visited

4. Identification of places visited

5. Places visited

6. Type of places and activities recognition

Swimming pool
Volleyball
Sport

7. Out-of-home activities
An external validation of models to predict the onset of chronic kidney disease using population-based electronic health records from Salford, UK

Paolo Fracaro, Sabine van der Veer, Benjamin Brown, Mattia Proser, Donal O’Donoghue, Gary S. Collins, Iain Buchan and Niels Peek

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
Showing Panel: Latest
Urea Creatinine K Comment Na Bicarb

Urea
- Source: Patient Entered Data
- Showing Result: 17-Nov-2016
- 7 mmol/l

Creatinine
- Source: Patient Entered Data
- Showing Result: 17-Nov-2016
- 4 micromol/l

K
- Source: Patient Entered Data
- Showing Result: 17-Nov-2016
- 6 mmol/l

Comment
- Available
- Source: Patient Entered Data
- Showing Result: 17-Nov-2016

Na
- Source: Patient Entered Data
- Showing Result: 17-Nov-2016
- 1 mmol/l

Bicarb
- Source: Patient Entered Data
- Showing Result: 17-Nov-2016
- 9 mmol/l
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