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Dr John Dinsmore, Head Innovation Lead, Trinity Centre for Practice and Healthcare Innovation
Advancing Digital Behavioural Change Interventions for Chronic Disease Management

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Trinity Centre for Practice and Healthcare Innovation

“Develop world-leading evidence based innovative research in the area of digital health”

All research participants for their time, commitment and valuable input

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1. Understanding the role of behavioural change in the design and development of digital behavioural change interventions (DBCIs)

2. Taxonomy and Framework to aid design and development

3. ProACT: Incorporating a behavioural change/science approach to the deliver a complex digital intervention into a complex healthcare ecosystem
**Behavioural Change (BC)** can be defined as the use of techniques such as motivating approaches, improving education, constructing a problem definition, serious gaming, continuing support and evaluation (Peyrot and Rubin 2007) to help individuals maximise their ability to act on personal and professional feedback to improve their health and wellbeing.
Role of Behavioural Change

Core components of cardiac rehabilitation

Lim et al Lancet 2012

Hasnain M Dalal et al. BMJ 2015;351:bmj.h5000
Digital behavior change interventions (DBCIs): are interventions that employ digital tech to encourage and support behavioral change that will promote and maintain health, through primary or secondary prevention and management of health problems

- Behavioural change is poorly understood and implemented in digital health
- Design and development of many digital health interventions lack a solid theoretical basis for behavioural change
- Most have modest/variable effects
Challenge with Incorporating BC Theory

- Large amount theories and methods for intervention design and evaluation (83 identified) (Michie et al., 2014 & Prestwich et al., 2014)

- Majority generally poor specification, both in construct definitions and in the relationships between them.

- Most behavioral theories emphasized group-level and largely static generalization (predict average changes in outcomes in groups).

  Ideally, a good theory will provide both group-level and individual-level generalizations.
Opportunity for DCBIs

• Individuals that use digital tech have a wide range of data gathered about them. These “digital traces” are aggregated, connected, and organized and can be used for a variety of purposes such as highly targeted recommendations or inferring psychological characteristics, such as personality & personal preferences.

• Advances in Artificial Intelligence can enable more “context-sensitive” understanding of (teachable) moments to deliver interventions and behaviour change techniques.
Next Step: Theory into Practice

• Digital interventions using wearables/sensors can help assess theoretic constructs in context, at the appropriate timescale, and with minimal burden to ensure continued data collection over time.

• Behavioural Change Techniques (BCTs): “Active ingredients” within an intervention designed to change behaviour. They are:
  1. Discrete, low-level components of an intervention that on their own have potential to change behaviour
  2. Observable and replicable

CT Taxonomy v1

• Developed by 400 experts from 12 countries
• Clearly labelled, well defined, distinct, precise; can be used with confidence by a range of disciplines and countries
• Hierarchically organised to improve ease of use
• Applies to an extensive range of behaviour change interventions

The Behavior Change Technique Taxonomy (v1) of 93 Hierarchically Clustered Techniques: Building an International Consensus for the Reporting of Behavior Change Interventions

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Abstract
Background CONSORT guidelines call for precise reporting of behavior change interventions; we need rigorous methods of characterizing active content of interventions with precision and specificity.

Objectives The objective of this study is to develop an extensive, consensus-agreed hierarchically structured taxonomy of techniques [Behavior change techniques (BCTs)] used in behavior change interventions.

Methods In a Delphi-type exercise, 14 experts rated labels and definitions of 124 BCTs from six published classification systems. Another 18 experts grouped BCTs according to similarity of active ingredients in an open-sort task. Inter-rater agreement amongst six researchers coding 85 intervention descriptions by BCTs was assessed.

Results This resulted in 93 BCTs clustered into 16 groups. Of the 26 BCTs occurring at least five times, 23 had adjusted kappas of 0.60 or above.

Conclusions “BCT taxonomy v1,” an extensive taxonomy of 93 consensually agreed, distinct BCTs, offers a step change as a method for specifying interventions, but we anticipate further development and evaluation based on international, interdisciplinary consensus.

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### BCT Taxonomy v1: 93 items in 16 groupings

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<td>Reduce prompts/cues</td>
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<td>Commitment</td>
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### No. | Label | Definition | Examples |
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<tr>
<td>1.</td>
<td>Goals and planning</td>
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<tr>
<td>1.1</td>
<td>Goal setting (behavior)</td>
<td>Set or agree on a goal defined in terms of the behavior to be achieved. <strong>Note:</strong> only code goal-setting if there is sufficient evidence that goal set as part of intervention; if goal unspecified or a behavioral outcome, code 1.3, Goal setting (outcome); if the goal defines a specific context, frequency, duration or intensity for the behavior, also code 1.4, Action planning.</td>
<td>Agree on a daily walking goal (e.g. 3 miles) with the person and reach agreement about the goal. Set the goal of eating 5 pieces of fruit per day as specified in public health guidelines.</td>
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**AIMS:**

1- Challenge the EU focus on supporting a single disease framework of care to create a patient centric integrated care (IC) ecosystem to understand and manage multimorbidity.

2 - ProACT aims to develop and evaluate a cloud based open API to integrate a variety of new and existing technologies to advance ‘home based’ integrated care (IC) for multimorbidity self-management.

Key emerging trends to be incorporated into the ProACT integrated care include; the consumerism of healthcare, the use of big data, developing patient centric ICT-AT approaches and open innovation models.
ProACT ICT-AT Platform

Person with Multimorbidity

Devices (e.g. Motiva, Withings, SmartThings etc.)

CareApps

support networks

CABIE

CareAnalytics

InterACT

powered by: IBM, NetwellCASALA, treologic, PHILIPS, Tyndall

built by: IBM, AIA, NetwellCASALA, treologic, PHILIPS, Tyndall
Meet Sarah

Sarah is 85

**Conditions:** Diabetes and Heart Failure

Everyday for the last 5 years she has measured her:

- Weight
- Blood Pressure
- Blood sugar

She writes readings in notebooks and brings them with her to her GP and specialist clinics that she attends for her conditions.

Sarah is finding it hard to remember when to take measurements and to write down the different readings into separate notebooks every day.
How Can ProACT Help Sarah

Monitoring Symptoms

• Sarah’s GP recommended that she try a new technology to help her monitor her symptoms automatically

• ProACT also help Sarah to keep track of other important parameters such as sleep, activity, mood and breathlessness.

Viewing Symptoms

• Her new devices now send her readings automatically to a tablet where she can view her symptoms over the last day, week or month
Knowledge and Education:

• The system also provides Sarah with tips that might be useful for her to manage her conditions and stay as healthy as possible.

• ProACT gives Sarah trustworthy and clear information on managing diabetes and heart failure but also on general topics such as exercise and how to get off the floor safely after a fall.

Health and Care Network:

• Person driven modular ability to personalise care network

• Sarah’s daughter Mary can view the health readings that she chooses to share with her from her phone.
**Systematically Incorporating BC into Design**

- **What is the aim of the system?**
  To improve self management skills and support for PwMs using a digital rather than paper based system

- **What is the behaviour that needs to change to do this?**
  PwM - needs to change their behaviour from managing their conditions using memory and paper based strategies to a digital self management tool

- **Systematic approach to address this?**
  The Behavioural Change Wheel approach involves an 8-stage process for developing behavioural change diagnoses and targeted interventional strategies.

  - **Synthesis of 19 frameworks to classify interventions**
    (health, environment, culture change and social marketing)
  
  - **Centre: COM-B model**
  
  - **Inner ring: Nine intervention functions**
    (what purpose(s) we the intervention serves)
  
  - **Outer ring: Seven policy categories**

  (Michie, Atkins and West, 2014)
Why apply the BCW model?

• Enabled us to design ProACT technology as a behaviour change intervention

• Understanding target behaviours within the framework of COM-B provides the first steps in selecting appropriate intervention strategies to bring about the desired change.

• UI Through the process of creating intervention strategies for each of the targets, we have translated intervention functions into additional application features.

• Behaviour change interventions may fail because the wrong assumptions have been made about what needs to change (Michie, Atkins and West, 2014).
Target 1: Measure and view key symptom readings on ProACT (Person with Multimorbidity)

<table>
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<tr>
<th>Intervention functions</th>
<th>COM-B components served by intervention functions</th>
<th>BCTs to deliver intervention functions</th>
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<td>Education</td>
<td>Psychological capability</td>
<td>5.1 Information about health consequences</td>
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<td></td>
<td>Reflective motivation</td>
<td>1.2 Feedback on behaviour</td>
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<td>2.7 Feedback on outcome(s) of the behaviour</td>
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<td>7.1 Prompts/cues</td>
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<td>Training</td>
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<td>Automatic Motivation</td>
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<td></td>
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<td>8.3 Habit Formation.</td>
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<td>Physical opportunity</td>
<td>12.5 Adding objects to the environment.</td>
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<td></td>
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<td>12.1 Restructuring the physical environment.</td>
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<td>Persuasion</td>
<td>Reflective motivation</td>
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<td>Enablement</td>
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<td>Incentivisation</td>
<td>Reflective motivation</td>
<td>10.4 Social reward</td>
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</table>
BCW: Implications for Analytics

• BCW has highlighted the importance of *User Engagement metrics and analytics* to help us to evaluate ProACT as a BC intervention

• The BCW has highlighted the need for the *personalisation* of behaviour change techniques and interventions which we have considered in the design of our CareAnalytics (PROACT Artificial Intelligence - IBM)
GOAL SETTING

• **Presents particular challenges and complexities** for multimorbidity. Due to link with age additional conditions impact on ability to achieve goals.

• **S.M.A.R.T goals (Doran, 1981) were not common practice** for PwM or care network. Goals were general and not measureable.

• **Issue:** Lack of awareness around types of realistic goals to set, lack of support from care network (time, not wanting to overload PwM, sense PwM should self direct, care network insufficient data to inform goals). Peer rather than clinical support a key motivator.
1. Data cleaner
2. Probabilistic Health and Wellness Profile Builder
3. Goal Recommender
4. Education Recommender
5. User Engagement Analyser
Evaluating ProACT as a BC Intervention

Each of the BC targets will be evaluated by:

- **Analysing system usage statistics** – how participants engage with specific features of the system i.e. measuring symptoms, recognising change, view education content

- **Quantitative trial assessment data (assessment measures)**

- **Qualitative interview data** – Thematic Analysis – Understand experiences

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**23 key metrics including**: Session length, dashboard time, reflection screen time, view readings time, view reading screen responses health tips time, my info time, button presses on each screen, daily app opens etc.

**19 Assessments including**: Usability (T2;T3;T4), Burden (T2;T3;T4), technology proficiency (T1;T4), social connectedness (T1, T4), QoL (T1-T4), self efficacy (T1-T4, illness perceptions (T1-T4), self-management (T1-T4), Demo (T1), med lists (T1;T4)

Interview schedules, reflect key assessment areas above.
Conclusion

• **DBCIs require theories and models of behavior change** that capture and take into account **individual variation and changes over time** and in context.

• There should be increased movement toward **theories and models that are as precise, quantitative, and testable** as possible for describing the complexity of behavior change.

• Digital interventions should **systematically adopt behavioural change approaches**.

• The inherent complexity of behavior change implies that no one research group is likely to, alone fully understand its application in DBCI’s. **Need for more transdisciplinary research consortia.**