Understanding and adapting to complexity

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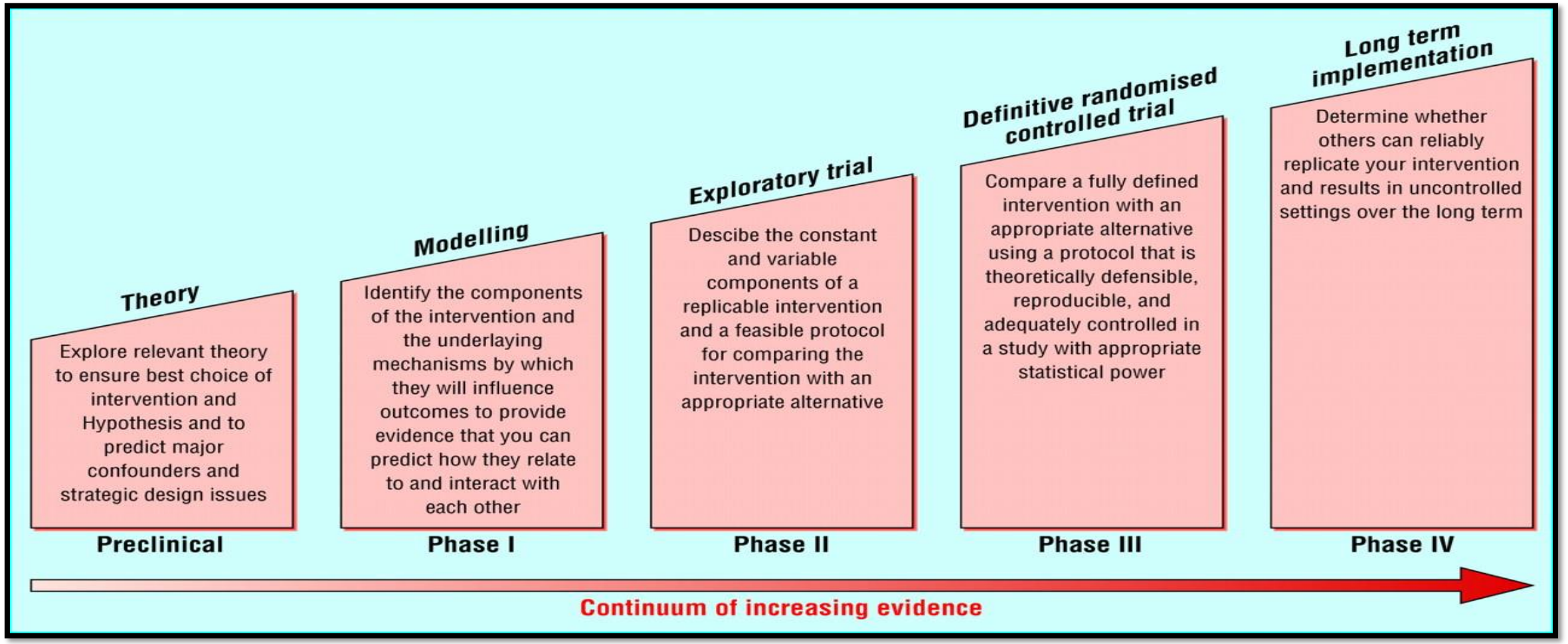
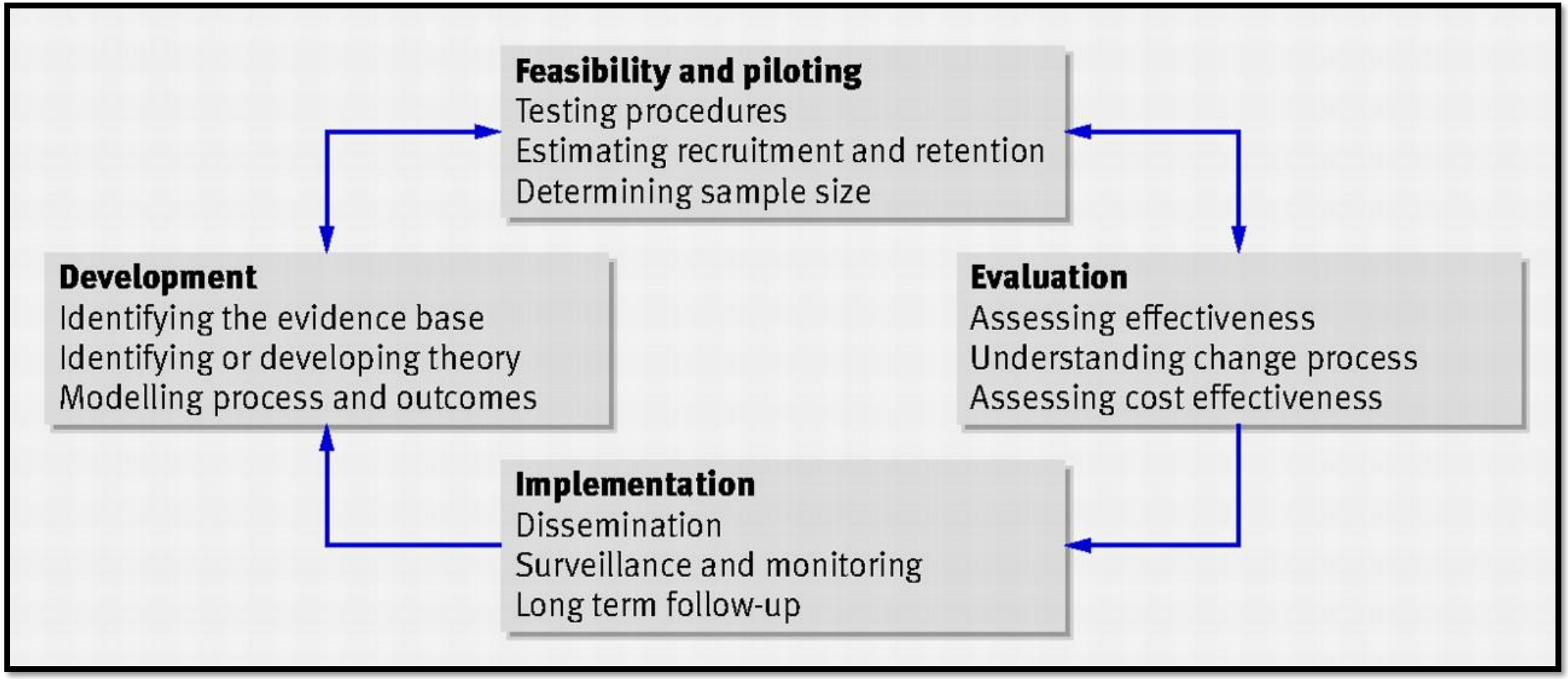
Overview

- This session will discuss
  - The historical and contemporary influence of complex systems perspectives in guidance development for health intervention research in the UK;
  - Definitions of a complex systems perspective, including i) what is meant by the terms ‘complex intervention’, ii) a ‘complex system” iii) intervention as an ‘event within a complex system’
  - Practical implications of complexity, and a complex systems framing, for development, evaluation and implementation of interventions

Phases for RCTs of 'complex' interventions: UK Medical Research Council framework (Campbell et al., 2000)



UK MRC guidance for developing and evaluating complex interventions (version 2; Craig et al. 2008)



More recent guidance from UK MRC (and other funders)

Theory and methods

Using natural experiments to evaluate population health interventions: new Medical Research Council guidance

Peter Craig,[1] Cyrus Cooper,[2] David Gunnell,[3] Sally Haw,[4] Kenny Lawson,[5] Sally Macintyre,[6] David Ogilvie,[7] Mark Petticrew,[8] Barney Reeves,[9] Matt Sutton,[10] Simon Thompson[11]

CIHR IRSC

NHS National Institute for Health Research

Taking account of context in population health intervention research: guidance for producers, users and funders of research

Peter Craig,[1]* Erica Di Ruggiero,[2] Katherine L Frohlich,[3] Eric Mykhalovskiy[4] and Martin White[5] on behalf of the Canadian Institutes of Health Research (CIHR)–National Institute for Health Research (NIHR) Context Guidance Authors Group (listed alphabetically): Rona Campbell,[6] Steven Cummins,[7] Nancy Edwards,[8] Kate Hunt,[1] Frank Kee,[9] Charlotte Loppie,[10] Laurence Moore,[1] David Ogilvie,[5] Mark Petticrew,[11] Blake Poland,[2] Valéry Ridde,[12,13,14] Jeannie Shoveller,[15]

RESEARCH METHODS & REPORTING

Process evaluation of complex interventions: Medical Research Council guidance

Graham F Moore,[1] Suzanne Audrey,[2] Mary Barker,[3] Lyndal Bond,[4] Chris Bonell,[5] Wendy Hardeman,[6] Laurence Moore,[7] Alicia O'Cathain,[8] Tannaze Tinati,[3] Daniel Wight,[7] Janis Baird[3]

Open access Communication

BMJ Open Guidance on how to develop complex interventions to improve health and healthcare

Alicia O'Cathain, Liz Croot, Edward Duncan, Nikki Rousseau, Katie Sworn, Katrina M Turner, Lucy Yardley, Pat Hoddinott

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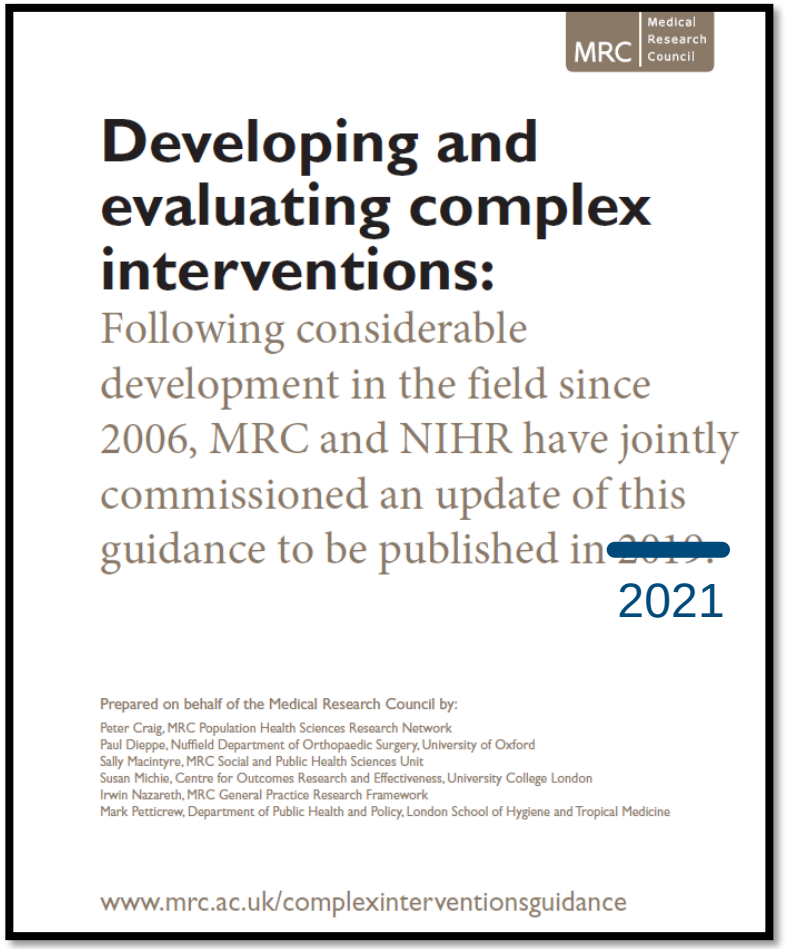
UK MRC guidance, version 3?

- MRC guidance being updated
- Recognition that thinking has moved on
- Integration of a complex systems perspective as a major theme within this
- This is due any day…!



What is a complex intervention anyway?

- Most of these use the term **complex intervention**
  - But **what** is complexity? What makes an intervention complex? Is any social intervention ever simple, or are we always dealing with degrees of complexity?
  - **Where** does complexity primarily reside (within the intervention's components, or the context)?
  - **Why** does complexity matter for research into population health interventions?

What is complexity? What makes an intervention complex?

What is a complex intervention? UK MRC definitions
(Campbell et al. 2000)

- Early MRC guidance focused on number of interacting components, and the interaction between them

  - "The greater the difficulty in defining precisely what, exactly, are the "active ingredients" of an intervention and how they relate to each other, the greater the likelihood that you are dealing with a complex intervention." (Campbell et al. 2000)

- Lots of parts which work in synergy to produce change, via difficult to identify causal mechanisms=complex intervention

  - Complexity as ***internal*** to the intervention

What is a complex social intervention? Updated MRC definitions (Craig et al. 2008)

- Still focused on the number of intervention components and interaction between them

- But some aspects of complexity reside within the context into which change is introduced

  - **How difficult are the behaviour changes required by implementers?** Complexity as a relative concept linked to who is being asked to do it and what they were doing before

  - **To what extent is intervention "permitted" to change across contexts?** Interventions and contexts as adapting to one another over time

An example of a ‘complex’ intervention?

Example : COVID-19 ‘lockdown’ in the UK

Intervention components	Mechanisms of change			Intended Outcomes
Legislation restricting movement				
Social media and mass media “Stay Home Save Lives” Campaign	Reduced social interaction among the population	Lowered rate of infection and illness	Reduced pressure on health care services	Fewer fatalities (due to C19 & other causes)
Police deployed to challenge non compliers and enforce				

Why is Covid-19 lockdown a ‘complex’ intervention?

- From a traditional UK MRC perspective, this is a complex intervention because
  - It has several components
  - These are intended to work in synergy to produce change
  - The precise contribution of each component is difficult to isolate

- More recent thinking locates complexity primarily in the context where interventions take place, rather than their components

- Even ‘simple’ mono-component interventions may be complex in terms of their interactions with context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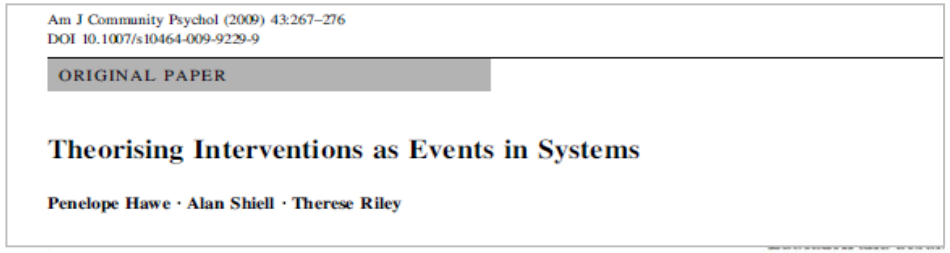
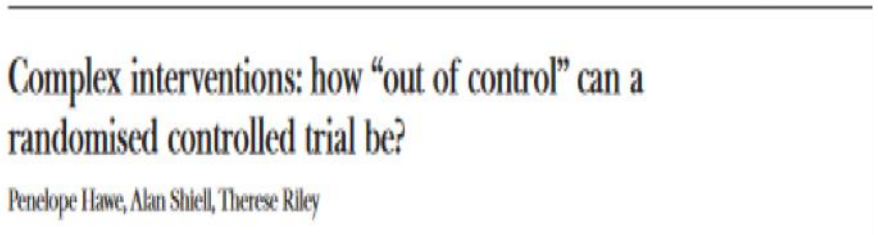
Editorial
All interventions are complex, but some are more complex than others: using iCAT_SR to assess complexity
Graham F Moore, Rhiannon E Evans, Jemma Hawkins, Hannah J Littlecott, Ruth Turley
11 July 2017


Analysis
Implications of a complexity perspective for systematic reviews and guideline development in health decision making
Mark Petticrew,[1] Cécile Knai,[1] James Thomas,[2] Eva Annette Rehfuess,[3] Jane Noyes,[4] Ansgar Gerhardus,[5,6] Jeremy M Grimshaw,[7,8] Harry Rutter,[1,9] Elizabeth McGill[1]


Am J Community Psychol (2009) 43:267–276
DOI 10.1007/s10464-009-9229-9
ORIGINAL PAPER
Theorising Interventions as Events in Systems
Penelope Hawe · Alan Shiell · Therese Riley


Complex interventions: how “out of control” can a randomised controlled trial be?
Penelope Hawe, Alan Shiell, Therese Riley

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Component focused definitions as "complicated" (rather than "complex")

Sending a rocket to the moon – ***complicated***

- Numerous components, which work in synergy
- But divisible into discrete tasks
- Careful application of formulae predicts replicable success

Raising a child - ***complex***

- Parents, and children, key actors in family systems.
- Difficult to isolate discrete aspects of parenting
- Or to isolate the role of parents from wider systems
- Outcomes not replicable or fully predictable
  - (Glouberman and Zimmerman 2002)

Complex (adaptive) social systems

Interventions delivered via systems such as schools, hospitals or other healthcare settings, which have many characteristics of complex systems:

- Shaped by ***interaction among diverse and ever changing agents***.
- A degree of ***autonomy***, but within limits set by wider political systems.
- System survival depends upon ***ceaseless adaptation***.
- Actions generate ***feedback loops*** that reinforce system behaviour, or lead to discontinuance.
- Propensity toward ***self-organisation,*** with order emerging through spontaneous interactions of agents within the system,
- Change creates disruption, triggering agents to self-organise to return the system to an ***attractor*** state (a new state of relative stability).
- Outputs are ***non-linear*** and may occur abruptly after a long period of no effect, as a threshold or ***tipping point*** is reached.

Interventions as ‘events’ within complex systems

- **Hawe et al. (2009)**
  - Population health outcomes are an **emergent** product of dynamic interactions among actors and groups within complex systems
  - Interventions occur at a particular time in the history of complex systems
  - The aim of intervention is to introduce changes, which will alter the dynamics of the system
  - Hence, where effective, interventions will act as a historical ‘event’ which meaningfully alters the course of the system
  - This will produce better outcomes for individuals, and the population as a whole

Example: Smoke free workplaces legislation

- Where we consider the context or system as the primary source of complexity, most interventions become complex
- **Smoke-free legislation** –'simple' in terms of components
  - But only possible as the system had reached a tipping point
    - 10 years earlier would have been "illiberal and authoritarian"
    - Capitalised on momentum from earlier advocacy work
      - reframing the debate around "harms to others" trumped libertarian objections and paved the way for future action
- Not a discrete 'intervention' with a clear beginning and end. Dependent on system history and contributing to future system trajectories

Another example: brief primary care intervention to encourage patient engagement with weight loss services (Aveyard et al. 2016)

- A component focused perspective treats this as a set of behaviour change techniques
  - If the doctor *does* things, this triggers change in the patient

- A complex systems perspective instead views the doctor-patient consultation as a dynamic activity setting
  - This setting has change potential because of the historically situated position and roles of actors within a health care system
  - Intervention about changing dynamics between actors within healthcare system to optimise health benefit

Earlier example: why is COVID-19 lockdown complex from a systems perspective?

- Seemingly simple causal chain linking actions to *intended* outcomes, **but** changing behaviour of individuals alters how society functions
  - **Family interactions**→ families locked down together with positive and negative consequences
  - **School-family interactions**→ school closures triggering adaption processes as they develop new ways to function
  - **Working from home** → triggered new ways of working within organisations
- Lots of harmful externalities
  - Worsening in child mental health; Increased poverty and socioeconomic inequality; Increased domestic violence; Substantial economic damage
- Catalysed additional intervention at multiple levels to mitigate harms
  - Funding for businesses who had closed to minimise redundancies
  - Varying local provision of meals for children who would go hungry without school meal
  - Various third sector (charity) responses around domestic abuse
- Complexity is about ***how the system responds to introduction of change*** not just about the components introduced to initiate change

All of the previous case examples: strong role for system histories and context

- Evaluations of effectiveness, such as RCTs, do not tell us that an intervention ‘works’
- They tell us that an intervention worked:
  - In a specific place
  - At a specific point in time
  - For the outcomes we chose to measure
  - In population in which it was evaluated

- Will it work elsewhere?
- Even within ‘the same’ health care, social care, education system etc, as these are constantly adapting, will an ‘effective’ intervention go on working forever?
- *Major challenge to traditional notions of evidence based healthcare*

Yesterday's solutions for tomorrow's problems?

- Following a traditional MRC framework model, it may take over 10 years from 'idea' to having firm evidence of effectiveness
  - 1 to 2 years development work
  - 2 to 3 year feasibility study
  - 3 to 5 year full trial

- It can then take years to get evidence into practice. All the while, systems are changing…

- Is the intervention development plan you had at the turn of the century still relevant to today's world?

Yes, it's all very complex, so what?

What does complexity actually mean for how we do intervention research?

Check for updates

Article

Evaluation
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From complex social interventions to interventions in complex social systems: Future directions and unresolved questions for intervention development and evaluation

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Improvement (DECIPHer), School of Social Sciences, C

ADAPT guidance v1.0 09-11-20 1

Adaptation of interventions for implementation and/or re-evaluation in new contexts: The ADAPT guidance (v1.0)

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Review article

Evaluation of public health interventions from a complex systems perspective: A research methods review

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ARTICLE INFO

ABSTRACT

Introduction: Applying a complex systems perspective to public health evaluation may increase the relevance and strength of evidence to improve health and reduce health inequalities. In this review of methods, we aimed to: (i) classify and describe different complex systems methods in evaluation applied to public health; and (ii) examine the kinds of evaluative evidence generated by these different methods.
Methods: We adapted critical review methods to identify evaluations of public health interventions that used systems methods. We conducted expert consultation, searched electronic databases (Scopus, MEDLINE, Web of Science), and followed citations of relevant systematic reviews. Evaluations were included if they self-identified as using systems- or complexity-informed methods and if they evaluated existing or hypothetical public health interventions. Case studies were selected to illustrate different types of complex systems evaluation.
Findings: Seventy-four unique studies met our inclusion criteria. A framework was developed to map the included studies onto different stages of the evaluation process, which parallels the planning, delivery, assessment, and further delivery phases of the interventions they seek to inform; these stages include: 1) theorising; 2) prediction (simulation); 3) process evaluation; 4) impact evaluation; and 5) further prediction (simulation). Within this framework, we broadly categorised methodological approaches as mapping, modelling, network analysis and 'system framing' (the application of a complex systems perspective to a range of study designs). Studies frequently applied more than one type of systems method.
Conclusions: A range of complex systems methods can be utilised, adapted, or combined to produce different types of evaluative evidence. Further methodological innovation in systems evaluation may generate stronger evidence to improve health and reduce health inequalities in our complex world.

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A few principles

- A systems perspective may involve use of methods from complexity science, such as systems maps, network analysis, systems modelling
- Perhaps more commonly, it is used as a lens to ‘frame’ research, often using more traditional evaluative methods (McGill et al. 2021)
- Some key considerations in a complex systems framing
    - Developing interventions which are **relevant to their context**, but defined **sufficiently flexibly to adapt** with their ever evolving systems
    - Evaluating interventions in ways which generates insight into ***how* interventions work in context** to aid future adoption and adaptation decisions
    - Continuously revisiting the **need for ‘effective’ interventions to be actively adapted** to maintain effectiveness

Building adaptability into intervention development

- Ceaseless adaptation is defining characteristic of complex systems.
- It follows that many interventions must continue to adapt as their surrounding systems do, or become redundant
- If we define interventions too rigidly in terms of their form, they may become redundant much more quickly
- Intervention ‘functions’ are (perhaps) more likely to be resilient to changes across time and space than intervention forms
- Ongoing work to understand how we can define interventions in terms of functions central to this
- **Key challenge:** Developing interventions which are:
  - relevant to a given context as it currently is and
  - sufficiently flexible to adapt as contexts change

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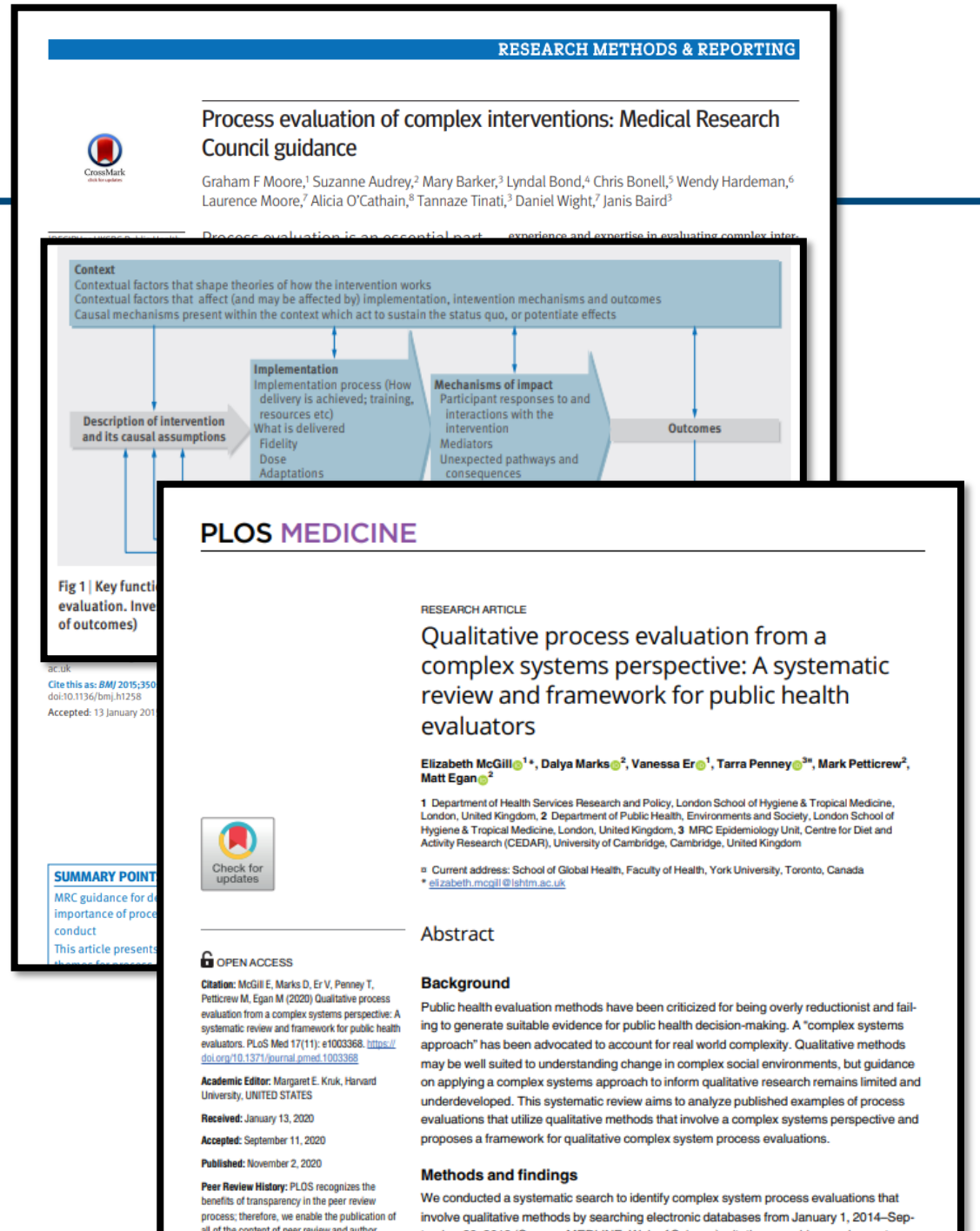
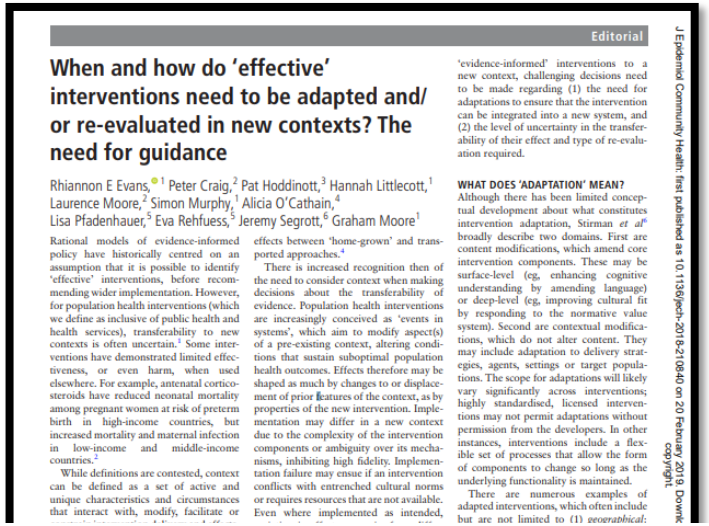
Evaluating process as well as outcomes

- Evaluating effectiveness of interventions is rarely enough
  - “effect sizes do not provide policy makers with information on how an intervention might be replicated in their specific context, or whether trial outcomes will be reproduced”
- Need for evaluations to pay close attention to questions of implementation, mechanisms, and context
- McGill et al have taken this work one step further
- 2 step framework for process evaluation focused on
  - Understanding the system prior to intervention
  - Understanding how it is altered by intervention



Adapting ‘effective’ interventions for new or changed contexts

- The ADAPT Study was largely motivated by growing recognition that context matters
- If we are adopting an intervention in the UK which is taken from the US for example
  - Is the US evidence enough to be confident it will work ‘here’?
  - Is uncertainty arising from difference in context so substantial we need a whole new randomised trial (or other outcomes evaluation study)?
  - Or can we be confident that so long as we can implement it as intended, contextual differences are relatively trivial, and it will work
- For ‘homegrown’ interventions:
  - Can we be confident that 10 years or more after their original (they will still work?
  - Does the original evaluation still provide a strong enough case investment?
  - Or have changes in the systems in which an intervention occu about whether it still works?



Editorial

J Epidemiol Community Health: first published as 10.1136/jech-2018-210840 on 20 February 2019. Downl copyright.

When and how do ‘effective’ interventions need to be adapted and/or re-evaluated in new contexts? The need for guidance

Rhiannon E Evans,[1] Peter Craig,[2] Pat Hoddinott,[3] Hannah Littlecott,[1] Laurence Moore,[2] Simon Murphy,[1] Alicia O’Cathain,[4] Lisa Pfadenhauer,[5] Eva Rehfuess,[5] Jeremy Segrott,[6] Graham Moore[1]

Rational models of evidence-informed policy have historically centred on an assumption that it is possible to identify ‘effective’ interventions, before recommending wider implementation. However, for population health interventions (which we define as inclusive of public health and health services), transferability to new contexts is often uncertain.[3] Some interventions have demonstrated limited effectiveness, or even harm, when used elsewhere. For example, antenatal corticosteroids have reduced neonatal mortality among pregnant women at risk of preterm birth in high-income countries, but increased mortality and maternal infection in low-income and middle-income countries.[2]

While definitions are contested, context can be defined as a set of active and unique characteristics and circumstances that interact with, modify, facilitate or

effects between ‘home-grown’ and transported approaches.[4]

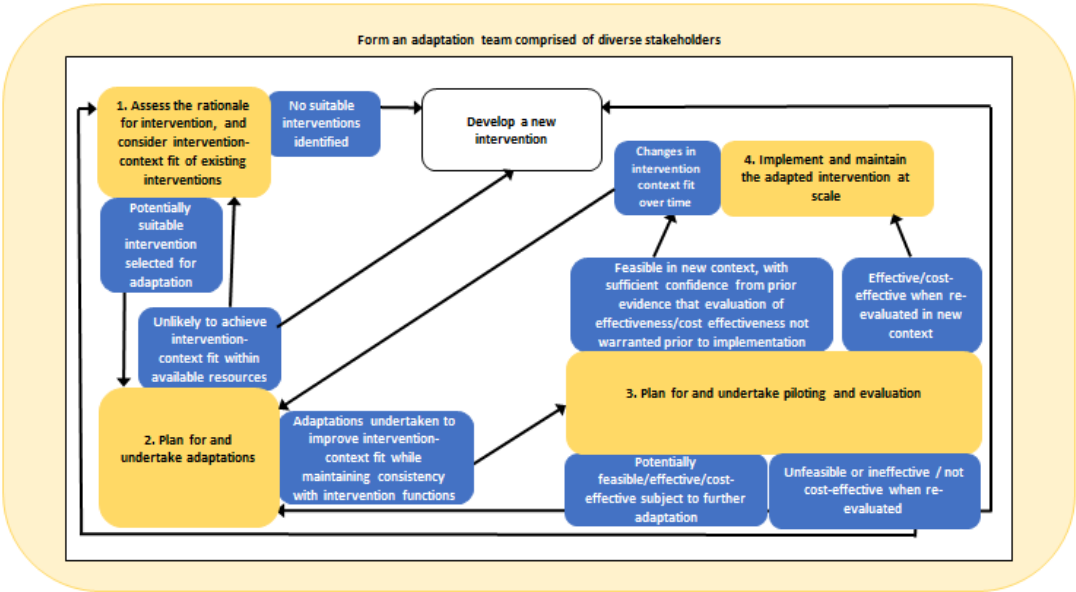
There is increased recognition then of the need to consider context when making decisions about the transferability of evidence. Population health interventions are increasingly conceived as ‘events in systems’, which aim to modify aspect(s) of a pre-existing context, altering conditions that sustain suboptimal population health outcomes. Effects therefore may be shaped as much by changes to or displacement of prior features of the context, as by properties of the new intervention. Implementation may differ in a new context due to the complexity of the intervention components or ambiguity over its mechanisms, inhibiting high fidelity. Implementation failure may ensue if an intervention conflicts with entrenched cultural norms or requires resources that are not available. Even where implemented as intended,

‘evidence-informed’ interventions to a new context, challenging decisions need to be made regarding (1) the need for adaptations to ensure that the intervention can be integrated into a new system, and (2) the level of uncertainty in the transferability of their effect and type of re-evaluation required.

WHAT DOES ‘ADAPTATION’ MEAN?

Although there has been limited conceptual development about what constitutes intervention adaptation, Stirman *et al*[6] broadly describe two domains. First are content modifications, which amend core intervention components. These may be surface-level (eg, enhancing cognitive understanding by amending language) or deep-level (eg, improving cultural fit by responding to the normative value system). Second are contextual modifications, which do not alter content. They may include adaptation to delivery strategies, agents, settings or target populations. The scope for adaptations will likely vary significantly across interventions; highly standardised, licensed interventions may not permit adaptations without permission from the developers. In other instances, interventions include a flexible set of processes that allow the form of components to change so long as the underlying functionality is maintained.

There are numerous examples of adapted interventions, which often include but are not limited to (1) *geographical*:



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Conclusions

- Historically, complexity has often been conceived as a property of multi-component interventions
- Complexity is now increasingly characterised as a property of the contexts in which interventions are implemented
- Complex systems perspectives emphasise the dynamic and ever changing nature of systems, and the need to understand how new ways of working interact with system histories and starting points

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