I sometimes ponder on the practical effect of the many words written on ‘public health’. And then I wonder, perhaps uncharitably, how many are merely a re-hash of what has already been said. So when a new book had not one, but four, concepts in the title, I was tempted to think that there might be something new, perhaps at the intersection of the four. Or was it another re-working of current knowledge? We already know a lot about the rise of inequality over the past three decades, and about ‘complexity science’ and its applications to health care, public policy, public health and health disparities.

This edited compendium serves as a capstone for the work of the multidisciplinary research programme of the Network on Inequality, Complexity and Health (NICH), originating at the turn of this decade at the University of Michigan. The members, all North American, came together in 2010 to bring complexity thinking into public health. They hoped it would permit them to think differently about recurring problems, and to propose new responses.

It’s well known now, as it was then, that concrete thinkers like to solve by direct means the types of problems in the authors’ sights. People are hungry? Provide hot meals while they find a job. Too many obese citizens in a neighbourhood? Encourage them to cut calories and raise exercise levels. Lots of crime? Crack down on the gangs, drug-runners and even the petty criminals; ‘three strikes and they’re in gaol’. The economy’s stagnant? Cut taxes for companies and watch the magical trickle-down.

If only things were that simple. When issues which look mono-dimensional have resisted easy answers, something different is needed. That’s where the NICH came in. As part of a self-assigned mandate, they dug deep into complexity science to figure out new ways to address such ‘wicked’ problems. They had noticed something profound—most research is cross-sectional, focusing on a single aspect of the problem: a survey, for instance, or a trial. This ignores the ubiquitous properties of systems and communities in which problems are situated. In fact, it treats these as confounders or variables to be controlled, rather than as importantly influential characteristics in their own right—variables which can’t be wished away, no matter how tempting that might be.

Those characteristics need to be understood and factored into proposed solutions. As any theorist should know, systems and communities are more than the sum of their parts. Participants (‘agents’) spend time relationship building, networking and making sense of their surroundings. They do not behave in linear ways, and do not respond in a 1:1 fashion to interventions. People comprising systems and communities do more than interact—they self-organize, co-evolve and adapt, dynamically. Participants respond haphazardly to rules from above but also create, or already have perhaps culturally, their own. If perturbed or put under pressure, they are often resilient—and even impervious to imposed change.

Big effects in complex systems and communities can come from seemingly small changes (e.g. having women control household resources in traditional, patriarchal societies), and disconcertingly small effects can result from large changes (restructuring health ministries or entire health systems, for example). In short, in complex structures, unpredictable things materialize. Things which have never happened before, happen often. There is always uncertainty and unknowability.
There’s more to it than that, of course. Any system or community creates, through all the interactions of individuals and groups, new patterns of behaviour at the next higher societal level. This is ‘emergence’. The point any system or community is at now depends to some extent on where it’s been, even back to much earlier times—complexity scientists call this ‘path dependence.’ For those wanting to positively influence the public’s health, there are other considerations. Any system contains sub-systems; behaviours at their interfaces matter. Local cultures and contexts can enable or constrain the best planned policy or strategy. Feedback mechanisms, formal or informal, can accelerate or retard behavioural change.

As its work progressed, the NICH group added new members and some dropped out. But its core activities remained. It set out on a different pathway from those who use existing data to examine public health issues, or who create their own or who conduct small- or large-scale interventions. They took existing data from the real world, put it into various in silico simulations they built themselves (typically, ‘agent’-based models), manipulated the key variables and ran the models over multiple sequences to see what would happen.

In modelling complex adaptive systems and those aspects of interest to them, they figured that the outputs of the models would tell them something new—even if the models were simpler than the real world they were simulating—not quite holding a mirror up to it (complexity science teaches that the real world is always messier than any model) but with sufficient granularity to examine speculations, investigate assumptions and test hypotheses. They put almost 10 years of their research careers on the line, securing a not insignificant amount of funding, to create these models. Was it worth it?

The answer, palpably, is yes. In silico modelling for public health was in its early stages when they started. ‘BigData’ were becoming available; desktop computing could handle modelling; applying complexity ideas was maturing. With this powerful convergence of resources and their multidisciplinary expertise, the NICH teams could shift from traditional research modes to studying the properties, over time, of dynamic systems—sometimes running models for the simulated equivalent of 500 years.

To give a flavour for the topics they covered, the book has chapters on macro systems-level problems, such as: exploring comparative health inequalities between the USA and Canada; looking at access to, and the functioning of, primary health care; weighing the ‘big picture’ factors affecting population health; and using Big Data sources from mobile devices to examine the properties of food-borne illness and to monitor consequent outbreaks. Chapters target more meso-level challenges, such as:

- factors involved in choice of college;
- how local neighbourhood food, exercise and education environments can reduce Black/White disparities in body mass index (BMI);
- the determinants of walking in cities;
- examining gender differences in propensity to exercise; and
- exploring the dynamics of the spread of crime.

There are also more specialized or micro-level simulations, such as those investigating dental health disparities and comparing social inequalities in distinctive social structures: US children in their kindergartens, and macaque monkeys in their troops.

All-in-all, this book has something for everyone interested in epidemiology. It is a master-class in how to model and how to apply complexity thinking to public health problems. There are some bonuses: some of the models are freely available for downloading and exploring, or can be obtained on request.

I have some some relatively minor quibbles. I wanted the book to summarize what the NICH group had learned about improving the health of populations under conditions of complexity and uncertainty, but the book is more interested in the lessons learnt from modelling, as laid out in the final chapter.

‘But what is the sum of all the knowledge they assembled?’ I asked myself. How should this feed into policy and practice to reduce inequalities and disparities, and to improve population healthiness? What next-generation questions would the NICH folks, knowing what they do now, now suggest? (Perhaps these could be subjects of their next book?)

I also wanted to surf the chapters but, most disappointingly for any book on science, there was no index. Did they finally exhaust their funds? Perhaps this could be rectified in a likely next edition or print run? Despite my uncharacteristic pessimism when I started this review, this book, despite being largely a summary of previously published work is paradoxically at the other end of the spectrum from ‘re-hash’. I give it high praise: it’s the best case for modelling the complexity of epidemiological problems I’ve seen.

### Funding

This work was supported by the Australian Institute of Health Innovation which receives much of its funding from peer-reviewed grants, chiefly, the National Health and Medical Research Council (NHMRC) funding which includes, most recently, the
Jeffrey Braithwaite
Professor of Health Systems Research and Founding Director, Australian Institute of Health Innovation, Macquarie University, Sydney, NSW
E-mail: jeffrey.braithwaite@mq.edu.au

References

1. Inequality.org. Facts: Income Inequality, Wealth Inequality. https://inequality.org/facts/wealth-inequality (12 December 2017, date last accessed).
2. Braithwaite J, Churruca K, Ellis LA et al. Complexity Science in Healthcare–Aspirations, Approaches, Applications and Accomplishments: A White Paper. Sydney: Australian Institute of Health Innovation, Macquarie University, 2017.
3. Geyer R, Cairney P (eds). Handbook on Complexity and Public Policy. London: Edward Elgar Publishing, 2015.
4. Kaplan GA, Galea S. Bridging complexity science and the social determinants of health. J Policy Complex Syst 2014;1:88–109.
5. Galea S, Riddle M, Kaplan GA. Causal thinking and complex systems approaches in epidemiology. Int J Epidemiol 2010;39:97–106.
6. Glass TA, McAtee MJ. Behavioral science at the crossroads in public health: extending horizons, envisioning the future. Soc Sci Med 2006;62:1650–71.
7. Diez Roux AV. Complex systems thinking and current impasses in health disparities research. Am J Public Health 2011;101:1627–34.