

ONLY CONNECT **Nicholas A Christakis****“You make me sick!”**

Network science can offer new ways to think about public health strategies

“You make me sick” is a colloquialism, but it reflects a reality. Our health depends not just on our own biology, choices, and actions but also on the biology, choices, and actions of those around us.

This claim may strike some as anathema. Particularly in the United States, we are accustomed to seeing our destinies as largely in our own hands. We “pull ourselves up by our bootstraps.” And we have a “do it yourself” culture that clearly extends to our own health. The radical individualist perspective is that by making changes in everything—from what we eat to how we exercise, how we brush our teeth, when we sleep, and whether we seek regular check-ups—we can improve our survival chances, mental stability, and reproductive prospects.

But the picture is much more complicated. Our unavoidable embeddedness in social networks means that events occurring to other people, whether we know them or not, can ripple through the network and affect us. A key factor determining our health is, in fact, the health of others. This is obvious when it comes to infectious diseases: if the people around you wash their hands or get vaccinated, it decreases your risk of infection. But it is also the case when it comes to other health phenomena. We are affected by the choices and actions of dozens or even hundreds or thousands of other people in our extended social network.

Hence network science can offer new ways to think about public health. For example, if we were trying to reduce the prevalence of smoking in a school or workplace, the conventional approach might be either to broadcast a message to everyone or to work with a small group of people who were believed to be especially at risk. In the second case, these individuals might be identified because they are the poorest, say, or because

they are known to be smokers. But an alternative approach would be to identify the people at the hubs in the social network—namely, those people at the centre of the network or those with the most contacts—and target them with smoking cessation messages and incentives, even though these people might not be either poor or smokers. Early results with such network based approaches have had success in fostering better diets and safer sex.

Some recent work has also clarified the specific circumstances whereby influential individuals are most apt to have an impact. A key consideration is that networks with particular patterns of connection are more prone to the spread of desirable (and undesirable) behaviours. Understanding the structure of social networks is crucial to understanding such naturally occurring and artificially induced diffusion processes, in both infectious and behavioural domains.

Understanding networks can lead to still other innovative, non-obvious strategies—related to infectious and non-infectious disease. Randomly immunising people in a population to prevent the spread of a pathogen typically requires that 80-100% of the population be immunised. For example, to prevent measles epidemics, 95% of the population must be immunised.

A more efficient alternative is to target the hubs of social networks. However, it is often not possible to discern network ties in a population in advance, when trying to figure out how best to immunise it. A creative alternative is to immunise the acquaintances of randomly selected individuals. This strategy allows us to exploit a property of networks even if we lack the time, money, or ability to discern the whole network structure. The reason that this strategy works is that acquaintances have more links and are more central to the network



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than the initial, randomly chosen people who named them; people with many links are more likely to be nominated as acquaintances than people with few. In fact, the same level of protection can be achieved by immunising roughly 30% of a population identified by this method that would otherwise be obtained if we immunised 99%.

Similar ideas can be exploited for the obverse problem: how best to conduct surveillance of a new behaviour (such as self-injurious “cutting,” which is epidemic among US adolescents at the moment) or a new pathogen or even a bioterrorist attack. Do we monitor people randomly or choose them according to their network position? Analytical models by Jure Leskovec and colleagues indicate that a choice informed by network science could be 700 times more effective and efficient at detecting outbreaks.

Such approaches shift the focus of decades of admittedly valuable public health work. They target neither socioeconomic inequality nor socioeconomic or behavioural vulnerability but rather structural inequality and structural vulnerability. As James Fowler and I argue, people can be placed at risk for bad or good health by virtue of their network position, and it is to this position that certain public health interventions might beneficially be oriented. As well as focusing on whether people are poor or where they live or even what they do, we might focus on who they know and what kinds of social networks they inhabit.

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ON THE CONTRARY **Tony Delamothe**

Thinking about Charles II

Charles II sometimes backed scientific evidence and sometimes backed belief. How different will the next King Charles be?

The heir to the British throne has been at the centre of controversy again lately—for his last minute intervention to stop a building development he didn't like and for the dodgy claims made for tinctures produced by his company.

While Prince Charles has form when it comes to architectural scraps, the Advertising Standards Authority's judgment against his company, Duchy Originals, broke new ground: its marketing was the first in the United Kingdom to fall foul of new European regulations governing alternative medicines (*Financial Times*, 6 May, www.ft.com/cms/s/0/5e108746-39d7-11de-b82d-00144feabdc0.html).

One of Prince Charles's objections to the new development was that it was unsympathetic to the nearby Royal Hospital, founded by Charles II. Which set me thinking about the reign of Prince Charles's namesake. Building the Royal Hospital, a retirement home for British soldiers unfit for further duty, seems A Good Thing. So, too, does Charles II's support of the fledgling Royal Society, formed within months of the restitution of the monarchy. (The society translates its motto as "Take nobody's word for it," which expresses its determination "to withstand the domination of authority . . . and to verify all statements by an appeal to facts determined by experiment.")

But what then are we to make of the stories that Charles II touched 100 000 of his subjects to cure them of scrofula (tuberculous lymphadenopathy)? At the time it was believed that English and French monarchs could cure the disease by their touch, having received this power from Saint Remigius via Edward the Confessor.

I wonder which will be the more powerful influence during the reign of Charles III: scientific evidence or belief? Rightly or wrongly, Prince Charles is widely perceived as being swayed much more strongly by belief. And finding the next king apparently lined up among the opposition is making the lives of the pro-science camp that much harder.

This matters because medicine is currently in the midst of a culture war between conventional and complementary medicine, with disputes about scientific evidence at its heart. Unsubstantiated claims for the efficacy of *Echinacea*, *Hypericum*, and detox tinctures tripped up the prince's company with the Advertising Standards Authority. But similar skirmishes are breaking out all over the place.

Last month Stephen Evans, a professor of pharmacoepidemiology, described it as "tragic that we now have a respected body, the Medicines and Healthcare products Regulatory Agency (MHRA), granting a licence for [Arnica 30 pills] for which there is not only no evidence of efficacy but good evidence against any efficacy" (*BMJ* 2009;338:b2332). David Colquhoun thinks the labelling of this homoeopathic remedy is "illegal" and makes a "mockery" of the aims of the MRHA (*BMJ* 2009;338:b2333). In this week's journal Edzard Ernst, Britain's first professor of complementary medicine, disputes the evidence that underpins the British Chiropractic Association's libel case against the science writer Simon Singh (*BMJ* 2009;339:b2766).

Meanwhile, on the battlefield, rumours thrive. Why doesn't the Department of Health first decide whether a treatment works before fussing about how to regulate it or how to train its practitioners? Why doesn't the department take the obvious decision of referring all complementary treatments to the National Institute for Health and Clinical Excellence (NICE) for its evaluation? How has the MRHA got itself into such a state over complementary treatments that respected researchers use words like "tragic," "illegal," and "mockery" when discussing its actions?

Bloggers have been joining the dots and believe they can discern the presence of Prince Charles, that indefatigable letter writer, behind these curiosities. But evidence for this is hard to come by, not least because

the Freedom of Information Act exempts communications between the royal family and the government. On the specific issue of homoeopathy, the prince's principal private secretary, Michael Peet, told the producer of the 2007 television documentary, *The Meddling Prince*, that the prince had never written to the MRHA on the topic nor had met the agency's chairman to discuss it.

Sir Michael had, however, written to complain to Edzard Ernst's vice chancellor about Ernst's scathing criticisms of a report on complementary medicine that had been commissioned by the prince (*Times*, 24 Aug 2005, www.timesonline.co.uk/tol/news/uk/article558458.ece). Ernst was eventually let off after a 13 month investigation with dark warnings from his vice chancellor about future disciplinary action (*BMJ* 2008;337:a2063). Sir Michael said that his letter of complaint was not prompted by the prince, who was unaware it had been written.

In the newspaper article that had precipitated the investigation, Ernst said that the Prince of Wales "seems to have overstepped his constitutional role," a charge repeated by *The Meddling Prince*. Richard Rogers, the architect whose building development was scuppered last month, has gone further, demanding a public inquiry into the constitutional validity of the prince's interventions in architecture, medicine, farming, and the environment.

On the question of such activism, does the reign of Charles II have any pointers for the future Charles III? It's hard to be sure. The British monarchy's constitutional powers were severely curtailed by the Glorious Revolution of 1688, hailed as a landmark in the long transfer of power from the Crown to Parliament. That wasn't during Charles II's reign, however, but three years later. Tony Delamothe is deputy editor, *BMJ* tdelamothe@bmj.com.

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“Finding the next king apparently lined up among the opposition is making the lives of the pro-science camp that much harder”



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Chiropractors: clarifying the issues

It is quite remarkable that scientists should expect themselves to become exempted from the laws of the land for publishing defamatory comments, be they about an individual or an organisation. Having mustered an army of supporters, including Evan Harris,¹ Simon Singh has redefined the battle as one of free speech and the stifling of scientific debate.² It is nothing of the sort.

The British Chiropractic Association (BCA) neither wished nor intended this matter to end up in the courtroom. When Dr Singh went on the offensive against the BCA and spoke of it promoting bogus treatments that had “not a jot” of evidence to support them,³ it was entirely understandable that the BCA should seek to have what were untrue and defamatory comments withdrawn in order to protect its reputation. It sought from Dr Singh a retraction of the allegations along with a public apology. Scientific debate could then have continued away from the law courts. However, despite receiving invitations to retract and apologise, Dr Singh refused to do either.

This case was never about enrichment; it was about fairly correcting libellous statements made about a respected national association representing more than half of the nation’s chiropractors.

There is in fact substantial evidence for the BCA to have made claims that chiropractic can help various childhood conditions.⁴⁻²² Contrary to how this case has been reported, it never claimed to cure these conditions, nor did it seek to dissuade parents from continuing with regular medical management.

Sadly, Dr Singh now argues for what he wished he had said, rather than what he did say. As a diversion from his defamatory comments, he has mounted a case for free speech and reform of the libel laws. The BCA fully supports free speech. However, with this fundamental right comes responsibility, and as a science journalist Dr Singh should not have published materials which he was fully aware would damage the BCA’s reputation.

Reform of libel laws will not take away the rights of a named individual or an organisation to protect their reputation when they are the victim of defamatory falsehoods. It is right that the law exists to protect them from the publication of untrue and unjust statements, and it is understandable that the government has hesitated in putting forward proposals for reform. Agreed, the costs of defending such actions may be prohibitive, but so are the costs of bringing an action. With awards for damages rarely exceeding the figure for costs, often neither party stands to gain financially, and reward is hardly ever the motive for resorting to the courts.

Chiropractors, as regulated healthcare professionals, should be accountable for their actions. They are subject to a code of practice²³ that exists to protect the public and uphold standards of care. They are also bound to practise evidence

based medicine, which, like that of their medical colleagues, comprises the best available evidence from research, the preferences of the patient, and the expertise of practitioners (including the chiropractor him or herself).²⁴ To reduce the definition of evidence to only randomised controlled trials not only is impossible but would exclude many medical interventions performed in general practice each day.

Contrary to the suggestion that chiropractic is purely synonymous with spinal manipulation, it is a primary healthcare profession that employs a range of interventions that benefit tens of thousands of patients each day. Had Dr Singh been serious about reasonable scientific debate he might have made due inquiry with the BCA before publishing his defamatory allegations.

The BCA is fully supportive of chiropractic research and indeed gives tens of thousands of pounds every year to support research initiatives throughout the UK. It is preposterous to suggest that the BCA seeks to either “stifle scientific debate” or engage in “chilling” science writers from expressing their views. The inclusion of spinal manipulation in the guidelines on low back pain recently published by the National Institute for Health and Clinical Excellence²⁵ was founded on peer reviewed, published research evidence demonstrating its efficacy. The risks of spinal manipulation have been researched, and two comprehensive studies in *Spine*^{26,27} demonstrated it to be far safer as an intervention than commonly prescribed medical interventions used for similar ailments.²⁸⁻³⁰

That esteemed figures within the scientific and medical communities have been mobilised to speak on this issue is a reflection of the feelings that this case has engendered. The indignance is palpable that a group of complementary health practitioners should dare to challenge the scientific establishment. Yet this case is not about challenging science or freedom of speech; it is about wrongly publishing damaging allegations.

Contrary to Dr Harris’s mistaken assertions,¹ the BCA never promoted or implied chiropractic as a cure, and peer reviewed papers that demonstrate symptomatic relief for childhood conditions were readily available. Dr Singh declined to answer the BCA’s request as to whether or not he had read, before the publication of his article, the evidence relied on by the BCA, arguing, bizarrely, that it was because the request was not relevant or necessary in order for the BCA to understand his case. This is odd because of Dr Singh’s new found opinion that the BCA is trying to stifle “scientific debate.”

In conclusion, before the BCA is further dragged through the mud by a concerted smear campaign, consider this: chiropractic has made huge strides to integrate itself into mainstream UK health care. It has enjoyed phenomenal popularity that is based on consistently delivering high quality care.

As a modern healthcare profession it welcomes examination of its methods, yet libellous statements are not the *modus operandi* that critics should employ.

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Chiropractic for paediatric conditions

The vice president of the British Chiropractic Association, Richard Brown, writes that there is “substantial evidence for the BCA to have made claims that chiropractic can help various childhood conditions.”¹ The association made similar statements in a press release,² because the science writer Simon Singh questioned statements made on the association’s website about childhood asthma, otitis, colic, feeding problems, sleeping problems, and prolonged crying.³ To back up his statement Brown provided 19 references.⁴⁻²²

Several of these references do not contain data relating to chiropractic treatment of the above named conditions.⁹⁻¹⁵ (See table.) Of the remaining 15, eight articles do not refer to controlled clinical trials but to retrospective analyses, observational studies, questionnaire surveys, and case reports, which tell us little about effectiveness.^{4,12,14,16,17,19,21,22} Here I will evaluate the remaining seven articles in more detail.^{5-8,13,18,20}

The “pilot study” by Bronfort and colleagues compared regular manipulations with sham manipulations for asthma.⁵ No effects were noted in lung function or hyper-responsiveness. The observed positive effects on quality of life relate to within-

group changes and are, the authors say, “unlikely a result of the specific effects of chiropractic SMT [spinal manipulative therapy] alone.”⁵

The randomised clinical trial by Wiberg and colleagues included 50 children with colic who received either chiropractic or dimeticone.⁶ In the chiropractic group, less crying was noted by the parents, but, because they “could not be blinded,”⁶ this might be due to a placebo response or other non-specific effects unrelated to chiropractic itself.

The “pilot study” by Mercer and Nook is available only as an abstract from conference proceedings.⁷ The data provided in this short summary are insufficient for critical assessment or for drawing meaningful conclusions about the effectiveness of chiropractic for colic.

Hawk et al published a systematic review of chiropractic care for non-spinal conditions, looking at the treatment of asthma, otitis, and colic, among other conditions.⁸ The authors included “chiropractic care” and studies of spinal manipulation or mobilisation not performed by chiropractors. Their positive conclusion regarding asthma relies on a study of osteopathic mobilisation of the ribs, and their conclusion of benefit for colic relies on the Wiberg study.⁶ The review does not contain additional positive data from

controlled clinical trials of chiropractic for the above mentioned conditions.

The Cochrane review by Glazener et al¹³ is an evaluation of miscellaneous treatments for bed wetting. The authors found only two trials of chiropractic. These were not of high methodological quality, and the authors referred to them as “weak evidence.”

The randomised controlled trial by Browning,¹⁸ published after Singh’s disputed commentary,²³ compared the effectiveness of two treatments of unknown effectiveness (manipulation and occipitosacral decompression). Similar improvements were noted in the two groups. The authors’ notion that “both treatments appear to offer significant benefit to infants with colic” is arguably unjustifiable, as both treatments might also have been similarly ineffective.

Finally, Reed et al randomised 57 children with enuresis to receive either real or sham manipulations every 10 days for 10 weeks.²⁰ The children in the experimental group had less severe enuresis already at baseline, and intragroup comparison of the number of wet nights failed to show a significant difference.

Although the content of the British Chiropractic Association’s list is important, its omissions are perhaps even more so. At least three relevant randomised controlled trials and two systematic reviews are missing from it.²⁴⁻²⁸ Arguably, these are the most rigorous papers in this area, but they fail to show that chiropractic is effective. The omissions are all the more curious as the association apparently knew of these articles. The association commented²⁹ on our review³⁰ that was based on this research, and the articles were part of Hawk et al’s review⁸ cited in the association’s list of evidence.

The association’s evidence is neither complete nor, in my view, “substantial.”

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Competing interests: EE has learnt spinal manipulation as a clinician and has published a book with Simon Singh, *Trick or Treatment? Alternative Medicine on Trial*. Cite this as: *BMJ* 2009;339:b2766

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The 19 articles listed as evidence by the British Chiropractic Association

Study	Type	Condition	Major weaknesses
Klougart ⁴	Case series	Colic	No control group
Bronfort ⁵	Pilot study	Asthma	No adequate control for non-specific effects Positive outcome observed only in intragroup comparison
Wiberg ⁶	Randomised controlled trial (RCT)	Colic	No adequate control for non-specific effects No validated outcome measure
Mercer ⁷	Pilot study	Colic	Reported only as an abstract
Hawk ⁸	Systematic review	All non-spinal	Not specifically on paediatric conditions No additional positive data from controlled clinical trials
Bockenbauer ⁹	Crossover study	Asthma	Not chiropractic (but osteopathy)
Guiney ¹⁰	RCT	Asthma	Not chiropractic (but osteopathy)
Mills ¹¹	RCT	Otitis	Not chiropractic (but osteopathy)
Froehle ¹²	Retrospective analysis	Otitis	No control group
Glazener ¹³	Cochrane review	Bed wetting*	Only two studies of chiropractic included Author’s conclusion: “weak evidence” provided by “small trials, some of dubious methodological rigour”
Nilsson ¹⁴	Questionnaire study	Colic	Not a clinical trial
Hayden ¹⁵	RCT	Colic	Not chiropractic (but cranial osteopathy)
Hipperson ¹⁶	Case report	Colic	Not a clinical trial
Miller ¹⁷	Theoretical framework	Prolonged crying	Not a clinical trial
Browning ¹⁸	RCT	Colic	Compared two treatments of uncertain effectiveness
Leach ¹⁹	Case report	Colic	Not a clinical trial
Reed ²⁰	RCT	Bed wetting*	Children in the chiropractic group had less severe bed wetting already at baseline No significant intragroup differences
Blomert ²¹	Case report	Bed wetting*	Not a clinical trial
Fallon ²²	Case series	Otitis	Not a clinical trial

*Bed wetting was not one of the six disputed conditions.