Public Health Asks of Systems Science: To Advance Our Evidence-Based Practice, Can You Help Us Get More Practice-Based Evidence?

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**THIS ISSUE OF THE JOURNAL** offers examples and promise of an underutilized methodology and a theoretical approach to some of the complex problems of public health on which other methodologies and disciplines have founndered. A central question posed by this collection is whether systems approaches can fill the gap that is felt most acutely by public health as it strives to rise to the paradoxical challenge of evidence-based practice. The challenge is that most of the evidence is not very practice-based.

The evidence given greatest credence and therefore the most play in evidence-based guidelines comes from highly controlled trials, ideally controlled by random assignment, but in fact made more artificial or unrepresentative by whatever methods of control are used. These methods are ineffective for taking into consideration the large numbers of variables, the great variability within them, and the diverse circumstances of public health practice. Indeed, they seek to take these variables out of consideration by controlling them, equalizing them, or holding them constant rather than variable.

Systems thinking and modeling seems to offer, among other things, an alternative to the controlled trial with simulation rather than control as the major source of evidence. It treats the multiplicity of variables as a resource to be used for deeper analysis rather than as a nemesis to be controlled. This, then, is the hope we harbor and the plea we seem to be making to systems scientists: Bring your theoretical and methodological tools for network analysis, knowledge transfer approaches, and systems organizing methods (including participatory research) to help us get a handle on the multiplicity of influences at work in the real world of practice, so that the evidence from our study of interventions and programs can reflect that complex reality rather than mask it.

**WHAT HAVE WE LEARNED FROM PAST EXPERIENCE?**

To cast the challenge to systems science in historical public health context, I recall a similar plea by the late Edward S. Rogers, who had led the rebirth of ecological thinking in public health in the 1960s. He challenged sociology 37 years ago in his essay in Science, “Public Health Asks of Sociology . . .” to bring the theories and methods of sociology to the aid of a field that was faced with a growing need for social and behavioral sciences to cope with complexities of the newly emerging epidemics of chronic diseases. Today’s plea to systems science has a strong echo of that early reaching out from public health. What can that history tell of the potential and pitfalls of harnessing other disciplines for our public health needs?

Most sociologists with any interest in health issues at that time (and still today) identified their subdiscipline as “medical sociology” and applied their health systems research mostly to the “sick role” of patients (from Talcott Parsons to David Mechanic) and to medical care systems. Some overlap with public health occurred with behavioral studies of health care utilization that included preventive health services (e.g., Ronald Andersen), access and socioeconomic studies that pertained to public health’s growing responsibility for Medicaid and indigent clinical care programs (e.g., LuAnn Aday), and the convergence of medical care, prevention, and self-care issues in the 1960s around mass immunization programs, the demographic and communications aspects of family planning, and the chronic conditions of aging.

Notable exceptions to the standoff of medical sociology from public health systems needs were the work of Sol Levine and his Johns Hopkins colleagues on interorganizational exchange relationships; the work of Gordon DeFriese and others at Chapel Hill; and Len Syme’s work at Berkeley in evaluation of community programs and social determinants of health, carried on notably at Harvard by Lisa Berkman and her colleagues in the tradition of social epidemiology.
It is especially in these latter intersections of sociology and public health where the organizational and social webs of causation and community behavioral norms draw us to systems thinking and modeling. This is partly out of some frustration with the limits of epidemiological methods and conventions in coping with the complexities increasingly recognized by public health.12–14

A first lesson from this experience is that we must open our own public health sciences to the transdisciplinary blending of methods and theories, and we must open them to the findings from the application of methods foreign to our prior traditions. As Susser points out in tracing the history and future of epidemiology, the leadership of chronic disease epidemiology that accompanied the infusion of social sciences into public health resisted examining the dynamics of the “determinants of health” variables that sociology was pointing us toward. We were content to draw on sociology for ways to measure socioeconomic status, for example, so that we could control for its confounding,15 but we were slow to use their socioeconomic variables to untangle the web of causation that such variables should have forced us to grapple with much sooner.

At the same time, medical care, the big-ticket item in health spending, has siphoned off resources from the newer disciplines we might seek to recruit to public health. Sociologists were understandably susceptible to accepting the more generous funding from the National Institutes of Health, the Agency for Health-care Research and Quality, and other agencies of government to apply their skills to study medical services rather than public health services. A similar fate with systems sciences is to be avoided, or we will see few of the benefits it promises for public health application.

A second lesson from the sociological experience is that the debates within such a broad field as systems thinking and modeling can undermine the credibility of the very methods and theories we might need to encompass. One of the most important sociological contributions to public health, for example, was the sociologists’ development of ecological analyses. Ironically, it was a sociologist, Warren Robinson, writing in a sociological journal, who became the most frequently cited authority for arguing the “fallacy of the ecological correlation” in epidemiological applications of ecological analyses to the understanding of what had become important to many chronic disease epidemiologists, namely, the risk-factor behaviors of individuals.16 As we embrace systems scientists, we must be prepared for the inevitable debates among them, in which they are arguing over nuances of their theories and methods. To us, these debates could seem like damning blows to the credibility of their entire enterprise or of some of the very methods that could be most valuable to public health.

While we contemplate the influence of subdisciplines in systems sciences, we might also recall that most of the social and behavioral scientists attracted to public health by Mayhew Derryberry’s recruitment to the Public Health Service in the 1950s (e.g., Hochbaum, Rosenstock, Leventhal) and the Russell Sage Foundation’s behavioral science initiative to populate schools of public health with such scientists in the 1960s (e.g., Knutson, Kirscht, Kegeles, Bruvold) were psychologists rather than sociologists. For all the enrichment of critical scientific and theoretical thinking on behavioral issues in public health that psychologists brought, their domination of that thinking could be seen in retrospect as regression to the individualistic mean and to the reductionist methodologies of experimental psychology rather than the community and systems thinking that Edward Rogers appealed to sociology to bring.

Thanks in part to the exposure of psychologists to public health and other social service fields, new subdisciplines of community psychology in the 1960s and environmental psychology in the 1970s emerged. We owe these psychologists, together with social psychologists, for their noble efforts to fill the gap between the preoccupation of psychology with individual differences and the needs of public health for population and organizational levels of analysis and intervention.17,18

The third lesson for public health, then, is that our recruitment of systems scientists to our cause should be cautiously discriminating of the systems science subdisciplines most responsive to our call and those most needed to address our needs. Each recruitment and appointment effort in public health should be preceded by a careful consultation with independent systems scientists on what we seek and what type of systems scientists among their colleagues can best meet those needs. The blind alleys down which we might otherwise travel could cost us decades of unproductive, misguided effort for public health, as our past preoccupation with attitudes and beliefs as primary targets for population-based strategies to change behavior might be seen in retrospect today.19

The social and behavioral sciences continue to be falling short in the theories and methods they bring to the systems needs identified by public health today. They have enriched epidemiological understanding of causation with their inductive methods, and they have strengthened interventions by filling the gaps in evidence-based best practices with theory. Most of their methods and theories, however, dominated as they have been by psychology, have not dealt adequately with the broader ecological understanding of causal webs and systems interventions that we seek today. Systems science, suggests Axelrod, offers a third alternative to our past dependence on the either/or or choices between inductive and deductive methods:

Induction is the discovery of patterns in empirical data. For example, in the social sciences induction is widely used in the analysis of opinion surveys and the macro-economic data. Deduction, on the other hand, involves specifying a set of axioms and proving consequences that can be derived from those assumptions . . . Simulation is a third way of doing science. Like deduction, it starts with a set of explicit assumptions. But unlike deduction, it does not prove theorems. Instead, a simulation generates data that can be analyzed inductively. Unlike typical induction, however, the simulated data comes from a rigorously specified set of rules rather than direct measurement of the real world. Whereas induction can be used to find patterns in data, and deduction can be used to find consequences of assumptions, simulation modeling can be used as an aid to intuition.20

The aid to intuition that the “evidence-based practices” movement has made us aware we need
to develop should make research responsive to the input and experience of practitioners and local planners. It should engage them as participants in the research process so that their intuition can be brought to bear on the specification of rules and on the interpretation of patterns. Systems thinking and modeling give ample attention to participatory approaches.

We turn today, with a similar motivation, to systems thinking and modeling to address the issues and needs invoked by Edward Rogers 40 years ago, but now with a more urgent beckoning by Congress and other financial forces to close the gap between what appears to be a backlog of research and its application in practice. The irony in this evolution is that some of the backlog of unapplied behavioral research in public health is because the research has missed the mark of public health needs, largely as a consequence of the appointment and promotion of scientists in the faculties of public health who had little or no experience in the practice of public health.

A fourth lesson, then, is to seek a more systematic promotion and tenure process to engage systems scientists in public health. This will provide them with experience in public health settings that their academic preparation and research has not provided and will provide incentives to study those systems in real time with real public health practitioners and planners.

**WHAT DO WE ASK OF SYSTEMS SCIENCE?**

**Overdetermined Systems**

Can systems thinking and modeling help us unravel, or strategically revealing, the myriad mediating and moderating variables that come into play when an efficacy-tested intervention is taken to scale from its controlled experimental setting to large communities or populations? Will it achieve methodologically what “ecological” approaches have offered conceptually as a way of encompassing the multiple levels necessary to understand and harness the reciprocal relations among biology, behavior, and environments?

**Recursive Feedback and Synergy**

Can systems thinking and modeling help us break out of the singularly linear analyses that have offered limited temporal analytic power in getting at the order of cause and effect, the feedback loops, and the synergistic relations (beyond interaction effects in analysis of variance or multiple regressions).

**Practice-Based Analysis**

At the heart of the rhetorical title of this article is the suggestion that we could be drawn to systems thinking and modeling if it had the potential to provide an enhanced inductive assessment of the practice setting and circumstances and the fit of alternative interventions, rather than with the deduction of fit for interventions tested in more sterile (and often artificial) circumstances provided for randomized and other control over “extraneous” variables. Do systems thinking and modeling really do so? Or are their initial modeling, network analysis, and simulation based on idealized or abstract versions of the realities of practice?

**Chaos**

Is the association of systems science with chaos theory an incidental affinity of some systems scientists? Or is it so central that public health would have to come to grips with the adoption of a chaos theory perspective on its own organization and entities? The term itself is misunderstood by the public and is off-putting for some health professionals who cannot reconcile the notion of chaos as a starting point for their practice, despite their sometimes futile efforts at organization and management. The challenging question for public health is which aspects of their practice can be understood best with linear models, which with nonlinear, and which with simulation?

**FROM SYSTEMS SCIENCE TO PUBLIC HEALTH APPLICATIONS**

**Which Concepts and Methods Will Be Most Useful?**

Among the many tools systems science has honed in other settings (mostly private sector?), which will have the greatest potential, and which will have the most immediate applicability and utility for public health policy and practice? Priorities need to be set because a dump of the entire array of concepts, methods, and data on public health will swamp the capacity of the field to absorb and use the concepts, methods, and findings of systems science. The priorities should be strategic, on either immediate needs, long-range potential, or both. How to weight these might depend on sponsorship and resources, which brings us to a second consideration.

**Who Will Absorb, Adapt, and Apply Concepts and Methods?**

Is the incorporation of systems science into public health to be a matter of recruiting and retooling existing systems scientists (as we tried to do with behavioral scientists 40 years ago) or an infusion of systems science into the curriculum of schools of public health and continuing education and (leadership?) training of more seasoned practitioners and policymakers? Or both? If we need to recruit systems scientists to public health, we need to learn from the prior experience with behavioral scientists that some will be more recruitable than others, but those most easily recruited will not necessarily be those most needed. We will have to be clear about public health needs and priorities and then recruit and incentivize accordingly.

If training new public health students and seasoned public health practitioners to incorporate systems thinking into their toolkit is the strategy of choice, we will still need to recruit some systems scientists, at least initially, to assist with the training.

If we must do some of both—recruiting systems scientists and training public health students in a new blend of practitioners—then would we do better to recruit systems scientists primarily through the academic public health door or through the policy and practice agency doors? The latter would seek to get the systems scientists acquainted with public health problems and settings before they attempt to teach public health students or conduct research that is little to do with public health needs.

**Who Will Support This New Addition to Public Health?**

Systems science is not a natural or easy sell to the National Institutes of Health. Support might be
a more probable fit for the Centers for Disease Control and Prevention, the Agency for Health Care Research and Quality, and the Health Resources and Services Administration, but they have little money to spare for academic training or new research in public health. Can we entice a foundation to sponsor an initiative like the Russell Sage Foundation’s behavioral science initiative in the 1960s, or the current Robert Wood Johnson Foundation’s population health fellows program, or Kellogg’s community researcher postdoctoral initiative? This would seem to be the next order of urgent business to advance what the articles in this issue seem to hold out as our hope for systems sciences in public health.

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