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

Public health asks of systems science, as it did of sociology 40 years ago, that it help us unravel the complexity of causal forces in our varied populations and the ecologically layered community and societal circumstances of public health practice.

We seek a more evidence-based public health practice, but too much of our evidence comes from artificially controlled research that does not fit the realities of practice.


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 founded. 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 the 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 Syne'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.

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It is especially in these latter inter-
sections of sociology and pub-
lic 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
modeling. This is partly out of
A first lesson from this experi-
ce 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 epidemiol-
ogy, the leadership of chronic
disease epidemiology that accom-
panied the infusion of social sci-
ences into public health resisted
examining the dynamics of the
"determinants of health" vari-
ables 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,5 but
we were slow to use their socio-
economic 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 re-
sources from the newer disci-
plines we might seek to recruit
to public health. Sociologists were
understandably susceptible to ac-
cepting the more generous fund-
ing 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 med-
ical 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 pub-
lc health application.

A second lesson from the so-
ciological 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' develop-
ment of ecological analyses.
Ironically, it was a sociologist,
Warren Robinson, writing in a
sociological journal, who became
the most frequently cited author-
ity for arguing the "fallacy of
the ecological correlation" in epi-
demiological applications of eco-
logical analyses to the under-
standing of what had become
important to many chronic dis-
ease epidemiologists, namely,
the risk-factor behaviors of indi-
viduals.16 As we embrace sys-
tems scientists, we must be pre-
pared 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 pub-
lc health.

While we contemplate the in-
fuence of subdisciplines in sys-
tems sciences, we might also re-
call that most of the social and
behavioral scientists attracted
to public health by Mayhew Derry-
berry's recruitment to the Public
Health Service in the 1950s (e.g.,
Hochbaum, Rosenstock, Leven-
thal) and the Russell Sage Foun-
dation's behavioral science initia-
tive to populate schools of public
health with such scientists in the
1960s (e.g., Krutzon, Kirsch,
Kegel, Brunow) were psycholo-
gists rather than sociologists. For
all the enrichment of critical sci-
cntific and theoretical thinking
on behavioral issues in public
health that psychologists brought,
their domination of that thinking
could be seen in retrospect as re-
gression to the individualistic
mean and to the reductionist
methodologies of experimental
psychology rather than the com-
munity and systems thinking that
Edward Rogers appealed to soci-
yology 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 en-
vironmental psychology in the
1970s emerged. We owe these
psychologists, together with so-
cial psychologists, for their noble
efforts to fill the gap between the
preoccupation of psychology with
individual differences and the
needs of public health for popu-
ation and organizational levels
of analysis and intervention.17,18

The third lesson for public
health, then, is that our recruit-
ment of systems scientists to our
cause should be cautiously dis-
criminating of the systems sci-
cence subdisciplines most respons-
ive to our call and those most
needed to address our needs.
Each recruitment and appoint-
ment 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, mis-
guided effort for public health,
as our past preoccupation with
attitudes and beliefs as primary
targets for population-based strat-
egies to change behavior might
be seen in retrospect today.19

The social and behavioral sci-
cences continue to be falling short
in the theories and methods they
bring to the systems needs identi-
fied 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 theo-
ries, however, dominated as they
have been by psychology, have
not dealt adequately with the
broader ecological understanding
of causal webs and systems inter-
ventions that we seek today. Sys-
tems science, suggests Axelrod,
offers a third alternative to our
past dependence on the either/
or choices between inductive and
deductive methods:

Induction is the discovery of pat-
terns in empirical data. For ex-
ample, in the social sciences in-
duction is widely used in the an-
alysis of opinion surveys and the
macro-economic data. Deduction,
by contrast, involves speci-
fying a set of axioms and proving
consequences that can be de-
duced from those axioms. . .
Simulation is a third way of
doing science. Like deduction, it
starts with a set of explicit as-
sumptions. But unlike deduction,
it does not prove theorems. In-
stead, a simulation generates data
that can be analyzed inductively.
Unlike typical induction, how-
ever, the simulated data comes
from a rigorously specified set of
rules rather than direct measure-
ment 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 mod-
eling can be used as an aid [to]
intuition.20,21

The aid to intuition that the
"evidence-based practices" move-
ment 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 unravel, 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 in schools of public health systems research that has 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 Healthcare 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 "demic training or new research in the absence of a 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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References