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Navigating the evidentiary turn in public health: Sensemaking strategies to integrate genomics into state-level chronic disease prevention programs

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ABSTRACT

In the past decade, healthcare delivery has faced two major disruptions: the mapping of the human genome and the rise of evidence-based practice. Sociologists have documented the paradigmatic shift towards evidence-based practice in medicine, but have yet to examine its effect on other health professions or the broader healthcare arena. This article shows how evidence-based practice is transforming public health in the United States. We present an in-depth qualitative analysis of interview, ethnographic, and archival data to show how Michigan's state public health agency has navigated the turn to evidence-based practice, as they have integrated scientific advances in genomics into their chronic disease prevention programming. Drawing on organizational theory, we demonstrate how they managed ambiguity through a combination of sensegiving and sensemaking activities. Specifically, they linked novel developments in genomics to a long-accepted public health planning model, the Core Public Health Functions. This made cutting edge advances in genomics more familiar to their peers in the state health agency. They also marshaled state-specific surveillance data to illustrate the public health burden of hereditary cancers in Michigan, and to make expert panel recommendations for genetic screening more locally relevant. Finally, they mobilized expertise to help their internal colleagues and external partners modernize conventional public health activities in chronic disease prevention. Our findings show that tools and concepts from organizational sociology can help medical sociologists understand how evidence-based practice is shaping institutions and interprofessional relations in the healthcare arena.

In the spring of 2013, Angelina Jolie revealed in the *New York Times* that she had been screened for hereditary breast and ovarian cancer (HBOC), that she had learned that she carried genetic variants elevating her risk of both cancers, and that she had decided to undergo prophylactic mastectomy to minimize her risk of disease. This dramatic announcement triggered increased demand for HBOC screening around the globe (Evans et al., 2014), and seemed to indicate that the long-awaited era of precision medicine had finally arrived. However, while screening for HBOC can be very beneficial, it is not recommended for all women, only for those with a very strong family history of breast cancer (U.S. Preventative Services Task Force (USPSTF 2005)). Genomics is thus not only elevating expectations for personalized medicine, but it is also pushing public health officials to embrace "precision public health," which tailors health promotion initiatives such as cancer screening to specific subpopulations (Khoury et al., 2017). Taking breast cancer as an example, a precision public health approach would entail initiatives to identify the small proportion of women who might benefit from screening for HBOC, while maintaining recommendations that typical-risk women receive biennial mammography starting at age 50 (USPSTF, 2016). To date, however, expert panels have recommended genomic screening for only a few conditions (breast cancer being one of them), and champions of genomic medicine and precision public health are eagerly awaiting evidence-based recommendations to guide further integration of genomics in clinical practice and in precision public health.

In this paper, we approach the advent of genomic medicine and evidence-based practice as converging *environmental jolts*—"sudden and unprecedented event[s]" requiring organizational change (Meyer 1982)—that are reshaping contemporary public health practice. While social scientists have examined the paradigmatic shift towards evidence-based practice in the medical profession (e.g., Timmermans, 2010), there has been limited exploration to date of how evidence-

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Table 1
Characteristics of evidence based medicine and evidence based public health.

	Evidence Based Medicine	Evidence Based Public Health
Application	For assessing the utility of novel healthcare innovations to maintain "quality of health care and cost control" (Timmermans and Kolker, 2005)	For "integrating science-based interventions with community preferences to improve the health of populations." (Kohatsu et al, 2004: 218)
Methodology	Standardized; randomized controlled trials and meta-analyses	Diversified; epidemiological research, quasi-experimental designs, natural experiments
Setting and actors	Medical schools, clinics Physicians, researchers, and patients	Multi-sectoral: Federal, state, local health departments Multi-professional: healthcare providers, engineers, lawyers, educators, community outreach workers
Prestige	High (Brandt and Gardner, 2000)	Lower prestige relative to medicine and underfunded (Brandt and Gardner, 2000)

based practice is affecting the other health professions, especially public health. Public health programming must be responsive to local context and characteristics, which complicates the implantation and standardization of evidence-based practices (Dobrow et al., 2004; Kirmayer, 2012); and the idea that there are "best solutions" overly simplifies policy decision-making processes (Kemm, 2006). While these challenges have been explored in international and cross-cultural contexts (Behague et al., 2009; Wang et al., 2018), the integration of evidence-based practice in US public health systems remains underexplored.

Evidence-based practice in US public health is an especially ripe area for sociological theorizing, in part because the public health profession is much more heterogeneous than the profession of medicine, but also because responsibility for public health policy landscape in the US is shared between the federal and state governments. As a result, we find that expectations for evidence-based practice in public health in the US have (1) created professional challenges that are distinct from the epistemological and professional challenges that coalesced in the evidence-based medicine (EBM) paradigm, (2) that public health professionals have needed to use different strategies to respond to these demands, and (3) that these factors have played out differently in different states, producing regional variations in the uptake of evidence-based practice (Senier et al., 2018). To illustrate the challenges of navigating this evidentiary turn, we present a case study of how one particular state health agency—the Michigan Department of Health and Human Services (DHHS)—integrated scientific advances in genomics into their chronic disease programming when discourses around both evidence-based public health (EBPH) and precision public health were emerging. We draw from organizational theory to demonstrate how program staff used sensemaking and sensegiving practices to explain why genomics could be relevant to public health at a time when they also had to adhere to evolving expectations for EBPH. This paper expands sociological literature on evidence-based practice, attesting to its significance as a force of change in the healthcare arena that extends beyond the scope of EBM. Moreover, the emergence of public health genomics is an especially valuable case to explore how multi-professional and multi-sectoral organizations negotiate and adapt to paradigm shifts. We argue that sensemaking and sensegiving are two critically important strategies through which complex organizations prepare themselves to respond to major disruptions in their field.

1. Background: understanding public health in a tumultuous era

In this paper, we identify two distinct environmental jolts that have recently affected the public health profession: (1) the advent of EBPH and (2) the mapping of the human genome and the rise of precision public health. While these jolts certainly affected medical care, our focus in this paper is how these two environmental jolts have challenged traditional models of chronic disease prevention, and how public health agencies have responded to these technological and practice innovations.

Surfacing in the mid-1990s, EBM was formulated with the intent of using research to guide diagnosis and treatment, and thus improve patient outcomes (Sackett et al., 1996). EBM has also been touted as a means for assessing the utility of novel healthcare innovations, such as antiretroviral therapies that mitigate the risk of mother-to-child transmission of HIV (e.g., Suksomboon et al., 2007). In this sense, EBM not only helps standardize medical practice but also provides a framework for assessing new discoveries, determining whether they are ready to integrate into clinical practice, and provides physicians with clinical practice guidelines to assimilate new routines into their clinic operations. Sociological research on EBM has focused primarily on three main areas: epistemological struggles over what constitutes evidence in the development of clinical practice guidelines, the impact of EBM on the medical profession's autonomy, and the effect of EBM on doctor-patient interactions (for a recent review, see Timmermans, 2010). Soon after the emergence of EBM, other health professions embraced the model, and today we see textbooks, journals, and professional curricula devoted to evidence-based nursing, evidence-based psychiatry, and evidence-based pharmacy, to name a few (Djulbegovic and Guyatt, 2017; Satterfield et al., 2009).

EBPH emerged shortly after the introduction of EBM and has been defined as "the process of integrating science-based interventions with community preferences to improve the health of populations" (Kohatsu et al., 2004:218). While public health has faced similar challenges to the medical profession's assimilation of EBM, we argue it is distinct from EBM for four reasons (see Table 1). First, the maturation of EBPH produced distinct epistemological and political difficulties (Brownson et al., 2009; Eriksson, 2000). In EBM, clinicians are trained to consider the most recent and highest-quality research in guiding diagnosis and treatment; this training is predicated on a hierarchy of evidence, with a strong preference for results of randomized controlled trials and meta-analyses (Timmermans, 2010; Victora et al., 2004). Public health research, however, employs a wider array of research designs, including epidemiological research, quasi-experimental designs, and natural experiments. As such, the knowledge base is less well suited to the knowledge synthesis techniques that have been lionized in EBM. Public health research also embraces a continuum of research activities, from problem identification through developing and fielding an intervention and evaluating its impact (Kohatsu et al., 2004; Satterfield et al., 2009). Consequently, it has been difficult to achieve consensus on the best criteria for synthesizing knowledge that could guide EBPH (McGuire, 2005).

Second, not only is public health's evidence base more unruly than medicine's, but public health is institutionally and professionally more diverse. The public health workforce includes not only healthcare providers, but also engineers, lawyers, educators, and community health workers (Brownson et al., 2009). Third, public health has historically occupied a less prestigious position than the medical profession, especially in the US (Brandt and Gardner, 2000; Starr, 2009), making it difficult for public health agencies to promote evidence-based practices that require the voluntary participation of healthcare providers (Brownson et al., 2009). Finally, relative to biomedicine, public

Table 2
Definitions of sensemaking/giving and resourceful sensemaking/giving.

	Sensemaking	Sensegiving	Resourceful Sensemaking	Resourceful Sensegiving
Organizational theory implementation	An ongoing process of ascribing meaning and order to experience. (Weick, 1995)	Attempts to influence sensemaking processes, to direct others' construction of an organizational reality. (Maitlis and Christianson, 2014)	Sensemaking that is mindful of others' perspectives and oriented toward expanding discourse. (Wright et al., 2000)	
Case: PHG implementation			To strategize; to align their activities with the broader field of precision medicine.	To secure cooperation and collaboration from colleagues; to help public health colleagues understand the relevancy of genomics.

health is woefully underfunded in the US, meaning that public health policymakers need to make difficult choices to prioritize public health problems (Trust for America's Health, 2018). This constrains their ability to experiment with novel or emerging technologies. But we argue that precisely because public health is a multi-professional, multi-sectoral profession that is usually the domain of complex bureaucracies (Trochim et al., 2006) that it presents an especially advantageous venue for understanding how evidence-based practice is reshaping inter-professional relations in the healthcare arena at large.

Examining the integration of genomics into chronic disease prevention programming as a case study, we demonstrate that state health agencies needed to deploy a combination of sensemaking and sensegiving strategies to translate novel scientific discoveries and imperatives for evidence-based practice for colleagues from many professions.

1.1. Sensemaking, sensegiving and organizational change

Sensemaking refers to how individuals ascribe meaning to experience (Weick, 1995; Weick et al., 2005). Although closely related to similar concepts in social psychology, symbolic interactionism, and collective movements (e.g., framing; Benford and Snow, 2000, Goffman, 1974), sensemaking is used in organizational sociology to unpack how people make new ideas actionable in a specific organizational setting. There are three important insights from sensemaking that bear on our analyses. First is that language and cognition are closely intertwined, and that the mental models that guide organizational practices are literally talked into existence (Hoff, 2013; Weick, 1995). Second, this communicative process is usually easier if people share a common professional or cultural background (Fennell and Warnecke, 1988; Hendy and Barlow, 2012). Third, in complex organizations, the social construction of reality unfolds across multiple levels. Some sensemaking discourses invoke legitimating paradigms that are accepted as truth within that organization or profession, while others are more improvisational and may be used to integrate new ideas into routine tasks and job responsibilities. A corollary to this point is that sensemaking can also be linked to the exercise of power, and some institutional actors may offer sensemaking narratives that hold greater sway in organizations as a result of their position in the hierarchy or their fluency in linking new ideas to dominant professional paradigms. Our paper shows how public health professionals have connected novel ideas about genomics to extant beliefs about public health's core missions.

The rise of evidence-based practice has coincided with a broader movement toward accountability and a preference for metrics and standardization, and although policymakers certainly have strong preferences for “hard metrics,” or quantifiable measures that assess quality of care, sociological research has repeatedly shown that sensemaking can be decisive in the adoption of new technologies (e.g., telemedicine) or routines that standardize care (e.g., infection control protocols, patient centered medical homes in primary care; Hendy and Barlow, 2012, Hoff, 2013, Lanham et al., 2013). For example, Martin et al. (2015) found that while executives in the English National Health Service relied heavily on hard metrics commonly included in reports, they also recognized the importance of staff and patient insights into the experience of care delivery. Similarly, Hoff (2013) found that organizations that succeeded in standardizing primary care around the Patient Centered Medical Home were able to draw on “hard taxonomies” (e.g., national standards and accreditation routines) as well as “soft practices” that honor the relations between patients and staff. Executives concerned about quality of care and patient safety must therefore attend simultaneously to hard metrics while also developing means of accessing subjective and interactional factors (Martin et al., 2015), which can be challenging because patient impressions and staff insights are hard to elicit or analyze. Current research shows that there is no one-size fits all approach to implementing best practices, and that

organizations need to assimilate expert guidelines or best practices in light of context-specific cultural and structural factors (Hendy and Barlow, 2012; Hoff, 2013; Martin et al., 2015). Sensemaking is therefore a powerful analytical tool to identify the ways organizations cope with major disruptions; it directs our attention to the ways organizations use objective metrics to measure change as well as the interactional and relational strategies they use to persuade their colleagues to embrace something new.

In this paper, we highlight reciprocal processes of sensemaking and sensegiving within public health organizations (see Table 2). Sense*making* delineates an organization's response to new or ambiguous circumstances, and accounts for individual- and group-level work around shared meaning, emotion, and cognition (Weick, 1995). Sense*giving* is defined as "the process of attempting to influence the sensemaking and meaning construction of others toward a preferred redefinition of organizational reality" (Maitlis and Christianson, 2014:67). Evidence has repeatedly shown that top-down directives from leaders or the issuance of expert panel recommendations is insufficient to spark lasting organizational change (Timmermans and Mauck, 2005). Meaning-making therefore is not a hierarchical project that is controlled solely by organizational leaders, and Charles R. Wright et al. (2000) have offered the notion of *resourceful sensemaking*, or a way of "appreciat[ing] the perspectives of others … to enact horizon-expanding discourse" (808). We find resourceful sensemaking compelling because it acknowledges that professionals need to construct frames that will resonate with peers. The professional diversity in multi-disciplinary, multi-sectoral public health organizations necessitates collaboration and exchange in sensemaking endeavors. While Wright et al. (2000) advance the notion of resourceful sense*making*, we propose a parallel concept of resourceful sense*giving* in which efforts to shape sensemaking processes consider the perspectives of multiple stakeholders. In the analyses that follow, we demonstrate how Michigan's Genomics Program staff used both resourceful sensegiving and resourceful sensemaking, to help their intra-agency colleagues and external partners understand how novel genomic discoveries can become part of EBPH, and to devote scarce resources to these endeavors in a time of austerity.

2. Methods and data

This paper presents an in-depth case study to show how the Michigan Genomics Program integrated genomics into their chronic disease prevention programming. We show how they coped with concurrent and intertwined jolts that arose from the advent of genomic medicine and escalating expectations that public health programs should be executed in a rigorous, evidence-driven manner. We selected Michigan's Genomics Program because it is nationally recognized for its leadership and innovation (Association of State and Territorial Health Outcomes, 2010). While the Michigan Genomics Program is not representative of all state genomics programs (it is older and has more robust funding and staffing resources than those in other states), many other states have replicated elements of their program (Senier et al., 2017). Our findings therefore provide insight into how other state health agencies may respond to the shifting epistemological demands of EBPH as they relate to innovations in chronic disease prevention.

Between 2012 and 2015, we conducted 32 interviews with staff members of Michigan's Genomics Program and their collaborators, and six interviews with key informants familiar with public health genomics programs nationally. We utilized theoretical and snowball sampling to achieve a representative sample of actors involved with Michigan's Genomics Programs and to gain insights into their diverse perspectives (Charmaz, 2014). We began by surveying program documents, to familiarize ourselves with the Genomics Program's work, to generate an initial list of themes for the interview guide, and to develop a list of key informants who played critical roles in the development and implementation of the Genomics Program. Key informants included Genomics Program staff and collaborators who worked in a range of settings: federal agencies, national non-profit patient advocacy organizations, or academic institutions. As other actors emerged during data collection, we expanded our recruitment to include internal collaborators and external partners. Interviewees held a variety of professional credentials: genetic counselors, physicians, nurses, epidemiologists, clinic personnel, patient advocates, and partners from other state agencies, health care institutions, or third-party payers. Interviews elicited information about: the origins of Michigan's Genomics Program, challenges they faced in integrating genomics in public health programming, their response to rising demands for evidence-based practice, and the advantages and obstacles in collaboration. Interviews ranged from 30 to 90 min in length, and were recorded and transcribed. The Northeastern University IRB reviewed and approved the study protocol.

We also conducted 47.5 h of non-participant observation at meetings and events hosted by the Genomics Program, such as steering committee meetings, conference calls with colleagues in other state Genomics Programs, and professional conferences where they reported on their activities. The archival data contained approximately 155 documents, including publicly available materials (e.g., publications, educational materials, and information on the Genomics Program website) and internal correspondence (e.g., grant applications and memos).

Three members of the research team used QSR International's NVivo 10 Software to analyze the data, in the spirit of a grounded theory approach. We began by crafting our interview guide to address the activities conducted by the Genomics Program (as informed by our review of program documents) and to probe theories and concepts from medical and organizational sociology. Accordingly, our first-order codes reflected these themes, but we also identified new themes as they emerged from the data (Charmaz, 2014). The team met periodically to review the reliability of coding, discuss any discrepancies, and establish rules for coding practices. Triangulating data from interviews, archival materials, and field notes allowed us to compare the diverse perspectives that participants in the Genomics Program have about their activities and construct a more nuanced picture of their activities and the context in which they work.

3. Results

To navigate the evidentiary turn in public health and keep pace with the complex changes being introduced by the intertwined jolts of genomic medicine and evidence-based practice, we find that the Michigan Genomics Program needed to employ both sensegiving and sensemaking strategies in three ways to gain cooperation and support from internal colleagues, external collaborators, and funders. First, they connected novel developments in genomics and precision public health to a long-established public health planning framework—the Core Public Health Functions (CPHF). Doing this helped them show that genomics was, in fact, relevant to public health. Second, they leveraged public health surveillance data to illustrate the public health burden of hereditary cancers on Michigan residents. This dispelled the misconception that genomics and precision public health would play a negligible role in improving the health of Michigan residents. Third, they mobilized expertise to assemble a team of professionals who had the right kinds of expertise necessary to convening diverse stakeholders.

We show how the Michigan Genomics Program used *sensemaking* at two key stages—in the initial phases of program development, when they were trying to understand the likely impact of genomics on population health, and later, when expert panels began issuing the first wave of recommendations for genomics and chronic disease prevention. At this stage, the Genomics Program staff needed to refresh their sensemaking frames because their funders imposed new requirements on them for demonstrating population-level impact and taking measurable action to enact policies that would deliver these benefits to a wider

audience. The Genomics Program thus used sensemaking to climb an initial learning curve in program development; these sensemaking strategies needed some flexibility to help them continually innovate their programs in response to emergent developments in genomics and new expert panel recommendations. Conversely, the Michigan Genomics Program needed to use resourceful sensegiving to help their colleagues understand complex genomic topics and the relevancy of genomics in chronic disease prevention. They could not force genomics into chronic disease programming, but instead needed to persuade their colleagues to make room for something novel, at a time when human and financial resources for public health were scarce.

3.1. The Core Public Health Functions

While there are many planning models that guide public health programming (e.g., the maternal and child health pyramid of health services, the chronic care model), the CPHF is one of the oldest and most broadly applicable. The CPHF comprise "Ten Essential Public Health Services," sorted into three domains: assessment, policy development, and assurance. Assessment identifies health problems, proposes resources to address them, and presents results to decision makers. Policy development makes plans, sets priorities, and allocates resources to meet public health challenges. Assurance activities provide services to meet these policy objectives (Centers for Disease Control and Prevention, 2011; Handler and Turnock, 1996). The CPHF is not bound to the needs of any specific constituency or tied to any particular disease; it is a generic public health planning model that has guided public health practice in local, state, and federal public health agencies since the 1990s (Institute of Medicine, 1988).

3.1.1. Sensegiving

In one of our earliest interviews, a key member of the Michigan Genomics Program staff told us about her early career in public health. She was trained in genetics and knew comparatively little about public health when she joined the MDHHS. In her interview, she explained how the CPHF helped her delimit public health responsibilities and objectives: "And I was trying to figure out, where is the structure here … [that] pulls everything together? And why are these things public health and other things not public health? So, I came across the ten essential services and the three core public health functions" (Interview 1, Genomics Program Staff, November 2012). From personally experiencing such powerful insight in how genomics and public health could fit together, she deduced that the CPHF could be a good strategy for helping her colleagues see genomics as relevant to chronic disease prevention, not just something that belonged in the province of boutique healthcare. The Michigan Genomics Program staff thus employed sensegiving discourses that related novel genomic advances to each of the three CPHFs, to make genomics more familiar to their colleagues within the DHHS (Beskow et al., 2001; Wang and Watts, 2007). Some of their colleagues were initially unconvinced that genomics was relevant to public health for two reasons: they either viewed genomics and heritable conditions as not modifiable—and therefore outside public health's purview—or, if they did acknowledge that genomics could be useful in tailoring prevention strategies, they viewed such customized advice as being relevant only for patients and physicians, and thus not pertinent to public health promotion. One Genomics Program staff member explained that it was necessary to remind people that chronic disease is likely the result of a complex interaction of genetic and environmental factors, which places genomics and precision public health clearly in the realm of public health concerns. She said, "if … they think of genomics as … a non-modifiable risk factor, you are dead in the water. Because public health is not going to be interested in that" (Interview 1, Genomics Program Staff, November 2012). Using the CPHF as an exercise in resourceful sensegiving with their peers and colleagues helped them to make precision public health accessible by situating novel innovations within a familiar framework.

The CPHF was especially useful in the earliest days of program development, when there was uncertainty about the likelihood that genomics would substantially improve population morbidity and mortality. The Genomics Program staff used their understanding of gene-environment interactions and the CPHF to show their colleagues how public health genomics provides tailored advice to subpopulations who may be especially at risk as a "way to show, hey, we're *not* doing something that only has an application to this very small segment" (Interview 7, Genomics Program Staff, March 2013). For example, they designed programs to help the public understand the importance of knowing one's FHH, and also devised curricula to help physicians become more accustomed to collecting this data and spotting "red flags" that suggest a patient should be referred to a genetics professional. These activities put the DHHS and providers in a position of readiness, so that they would be prepared to take action if and when expert recommendations came out.

Very soon after launching their program, evidence did begin to accumulate that genomics could make a difference in population-level morbidity and mortality, thus placing it even more squarely within public health's jurisdiction. For example, in 2005 the U.S. Preventative Services Task Force (USPSTF) recommended that practitioners screen women for a strong family history of breast cancer and refer those patients for HBOC screening (USPSTF, 2005). Although evidence of population health impact remained limited, the USPSTF reasoned that genetic counseling and testing could provide risk estimates and direct individual patients toward interventions that would forestall development of disease or minimize its impact, e.g., prophylactic mastectomy (Nelson et al., 2013). The UPSPSTF anticipated that if providers and the public followed such recommendations, women at risk of HBOC would have better health outcomes and it would be plausible to also expect improvements in population health. HBOC screening thus gained legitimacy as a public health promotion strategy, because an expert panel had endorsed it and funding agencies supported it as a public health promotion activity.

Under this rationale, Michigan's Genomics Program proposed activities that touched on all three CPHF: they analyzed state health statistics to estimate the burden of HBOC and proposed policy development and assurance activities to identify women with a family history of breast cancer and refer them to cancer screening services at a younger age than typical women. Reframing genomics as something that could be relevant for *groups* of people, rather than individuals, and using the CPHF to organize that message was a critical sensegiving strategy during this time. The approach was entirely consistent with public health practice and the USPSTF recommendations for HBOC genetic screening (Nelson et al., 2013; USPSTF, 2005). Speaking to the urgency of this task for public health, one leader in the DHHS said, "it's terribly important to discover this stuff [about genetics] … if there's going to be discovery here, let's not … take fifty years to get it into the public" (Interview 10, Michigan DHHS administrator, March 2013).

3.1.2. Sensemaking

The CPHF turned out to be important not only in helping the Genomics Program staff explain and legitimize genomics for their internal colleagues but also in responding to the expectations for EBPH that came from their peers within the broader public health profession. They needed to implement rigorous evaluation techniques to demonstrate concrete impacts on population health. In this endeavor, the CPHF was most helpful in ensuring themselves their own programming was comprehensive and data driven.

Throughout our interviews, Michigan Genomics Program staffers described how the early years of their program brought rapid changes in genomics, and how they needed to continually cope with ambiguity surrounding new scientific developments. For example, the number and range of chronic diseases that were implicated in precision public health expanded to include other hereditary cancer syndromes and cardiovascular disease (e.g., Evaluation of Genomic Applications in

Practice and Prevention Working Group, 2009; National Institute for Health and Care Excellence, 2013; USPSTF, 2005).

These developments influenced funders' priorities; thus, if the Michigan Genomics Program wanted to retain their funding, they had to be nimble about incorporating new expert guidelines and EBPH routines into their funding applications. In 2008, the Centers for Disease Control and Prevention (CDC) issued a call for proposals that directed state public health genomics programs to focus more specifically on curbing morbidity and mortality from hereditary cancers. Due to limited funding, they issued grants to five states—Michigan, Oregon, Utah, Connecticut, and Colorado—with hope that the activities developed in these states could be adapted elsewhere, and that a modest investment in focused demonstration projects would diffuse evidence-based practices more broadly. While the CDC allowed states freedom to design surveillance and education projects, all applicants were required to include policy-related objectives. The Michigan Genomics Program staff was so thoroughly dedicated to the CPHF that they again organized their activities around the CPHF, and called the CDC to ask for clarification in crafting their application:

> [We asked] … can we do more than one of these areas—surveillance, education and policy? And they said, 'huh, no one has asked that question. We're going to have to figure this out.' So they came back and said, 'if you think you can do that within three years, yes, go ahead and put that in.' … No one else to my knowledge, is what I've heard, put in anything that addressed all three areas. … It was, I guess, highly competitive, is what I've heard. (Interview 1, Genomics Program Staff, November 2012)

The Michigan Genomics Program found that the CPHF, as a sensemaking paradigm, helped them meet the CDC's demands for *measurable outcomes* i.e., demonstrable improvements in morbidity and mortality from these conditions, and *policy action*, i.e., state health agencies' engagement in some sort of policy level work to meet targeted screening goals.

The reliance on the CPHF was so compelling that the Michigan Genomics Program staff's external partners also came to embrace it as a sensemaking strategy. For example, one of the diseases the Michigan Genomics Program sought to address after 2008 was Lynch syndrome, an aggressive form of colorectal cancer that runs in families and strikes at especially young ages. Michigan wanted to pursue policy development and assurance activities that would motivate providers to undertake cascade screening, e.g., genetic evaluation of biologically-related healthy family members (Maradiegue et al., 2008). To achieve this, they needed to persuade hospital pathology departments to institute universal tumor testing and then also persuade providers to promote family notification and referral. One of their external partners explained how the CPHF maintained coherence to their activities:

> So if you take cascade screening for Lynch syndrome, for instance, you've got the surveillance end of it because you want to keep gathering data. You want to use databases that are already there. In terms of disease frequency, you want to keep assessing what you're doing—still part of that initial assessment function. Policies are essential. Where's the money going to come from? Can you get insurance companies to start covering this screening? And those kinds of issues. And then of course, assurance. How do you get this disseminated out into the community and with buy in so that people actually take family histories, see their physicians, let their family members know that they ought to get screened if there is already a problem identified and so on. So the framework worked there. (Interview 17, External Partner, November 2013)

The CDC was so impressed with Michigan's efforts that in 2011 they began encouraging other state health agencies to mimic this strategy of organizing activities around the three areas of CPHF. The Michigan Genomics Program's sensemaking activities thus paid further dividends, as their funder took Michigan's approach and encouraged other states to use the CPHF as a blueprint to launch their own genomics programs.

3.2. Utilizing data

The Michigan Genomics Program further solidified acceptance of their sensemaking and sensegiving activities by backing them up with hard metrics. They analyzed state public health surveillance data to quantify the potential impact of hereditary cancers on Michigan residents. This strategy appealed directly to the expectations and preferences that many policymakers have for quantifiable measures. Although they began their activities when the prospects for population-level benefits of precision public health were still uncertain, they took action early in their programming to establish a baseline of how genomic conditions may be affecting Michigan residents—the sort of baseline data that might allow them to demonstrate measurable improvements in morbidity and mortality over time. They were able to leverage some existing data sources but also needed to launch entirely new data collection initiatives.

3.2.1. Sensegiving

Assessment is an important CPHF; in our interviews, the Genomics Program staff explained that surveillance practices were critical to getting their colleagues to understand the importance of public health genomics and to allocate scarce resources to these activities. According to them, the mere existence of USPSTF recommendations was not enough to galvanize policymakers at the state level—they needed to show state-specific data to decisively demonstrate that hereditary cancers are a public health burden for Michigan residents (Interview 2, Genomics Program Staff, November 2012). Realizing this, the Genomics Program staff analyzed data from their state cancer registry to estimate the number of women in Michigan diagnosed with breast cancer before age 40 (early age at diagnosis being a rough proxy for familial cancer risk; Anderson et al., 2012). They generated reports for each hospital in the state, rendering visible the number of women who might unknowingly be at risk from hereditary cancers. They also paired these data with educational resources on evidence-based recommendations and a directory of genetics professionals at regional medical centers, where providers could refer patients for more intensive follow up (Senier et al., 2017). The Genomics Program's data practices used state-specific data to illustrate the potential disease burden for Michigan residents, demonstrating the local relevancy of USPSTF recommendations. Moreover, by pairing these reports with education and referral resources, they helped providers figure out how to align their own screening practices with EBM recommendations.

Another important data practice that supported their sensegiving strategy can be seen in their work on sudden cardiac death in adolescents and young adults, an issue that had garnered attention among patient advocacy groups and family charitable foundations in Michigan (Goble et al., 2017). Autopsies and molecular diagnostic testing have revealed that some patients who die unexpectedly at an early age from cardiac arrest suffer from rare genetic conditions (e.g., hypertrophic cardiomyopathy); in cardiovascular genetics, this phenomenon is known as sudden cardiac death of the young (SCDY), and is especially tragic when it strikes apparently healthy young athletes, as had occurred in Michigan. In 2003, Michigan's Genomics Program staff began to provide leadership on this issue, starting with a review of death certificates to estimate the public health burden of SCDY in Michigan (White et al., 2015). Their analyses of these hard data documented a small (but not trivial) number of such deaths annually, attesting to the public health burden of SCDY and making space for a public health response.

Based on this surveillance work, the Genomics Program staff convened a multidisciplinary stakeholder group, the Michigan Alliance for Prevention of Sudden Cardiac Death of the Young in 2012, to provide leadership, education, and resources to help Michigan communities prevent SCDY. The Michigan Alliance worked with family charitable

foundations and the HEARTSafe program to create an awards program that codified best practices for school cardiovascular programs. The alliance used data to describe the scope of the problem, and designed interventions that rewarded schools for measurable changes to school health screening (Goble et al., 2017). Nearly every member of Michigan's Genomics Program staff reported that they believed their use of data was not only critical to persuading their colleagues in the health department to address SCDY, but also key to the implementation of several public health interventions that engaged community stakeholders.

3.2.2. Sensemaking

Genomics Program staff used state-level data to persuade their colleagues of the value of genomics in chronic health, but they quickly ran up against some inadequacies of state surveillance databases—they simply did not have key variables needed to accurately measure genomic risk factors or to identify things that facilitate or prevent patients from receiving adequate care. For example, the state cancer registry does not have information on genetic variants and has limited information on FHH, so they had to resort to using age at diagnosis as a proxy. To correct these limitations, and to refine their own understanding of the problem, they embarked on one of their most ambitious sensemaking activities. Under their second CDC grant, they founded the BRCA Clinical Database—a partnership with cancer clinics statewide to capture more comprehensive data on patients referred for cancer genetic counseling. This was necessary to gather the kinds of data needed to demonstrate measurable progress toward the screening, morbidity, and mortality goals expected by the CDC in the EBPH era.

The BRCA Clinical Database was piloted in four cancer genetics clinics and ultimately expanded to 20 clinics statewide. Participating clinics entered data for all patients referred to them for genetic counseling. This allowed Genomics Program staff to determine how many women were receiving HBOC screening from a board-certified provider, how many of them proceeded to genetic testing, and reasons for not pursuing testing (Michigan Department of Community Health, 2012). The Genomics Program staff could use this database to compare a patient's FHH to the USPSTF guidelines, and determine if they were good candidates for HBOC screening, or if genetic clinics were being inundated with requests from the worried well. They could thus use this database to understand multiple dimensions of inappropriate use—both underutilization and overutilization of genetic testing.

One noteworthy finding was that 14.9% of women who received genetic counseling for HBOC did not proceed to genetic testing because of inadequate insurance coverage (Michigan Department of Community Health, 2012). This had significant policy implications—it suggested that not only did they need to educate providers and the public about HBOC screening, but they needed to encourage insurance companies to cover screening services in accordance with EBM guidelines. This insight from their sense*making* activities led to a sense*giving* opportunity, i.e., outreach with health insurance companies in Michigan. They shared hard data about the proportion of women who could not pursue testing because of inadequate coverage, and provided insurance executives with sample language that they could insert in insurance policies, to align their coverage with EBM recommendations (Senier et al., 2017). Just as with the cancer registry reports they provided to hospitals, their sensegiving strategy paired hard data with easy-to-follow instructions. On the whole, their sensemaking activities (i.e., creating new surveillance databases to understand the problem more thoroughly) thus became a springboard to further sensegiving activities, and identified a new audience (e.g., insurance company executives) who needed to learn more about public health genomics and evidence-based practice.

3.3. Mobilizing expertise

The Michigan Genomics Program staff further bolstered these sensegiving and sensemaking activities by leveraging expertise. For them, expertise was as much a relational strategy as it was a matter of technical capacity. The diversification of experts was symbolically and practically important to showing colleagues and external partners that they were prepared to meet new evidentiary demands.

3.3.1. Sensegiving

As noted, public health is a multi-disciplinary profession, requiring practitioners to engage the public, providers, policymakers, and their peers within the state health agency. From their inception, the Michigan Genomics Program prioritized hiring professionals with specific yet diverse types of expertise (e.g., genetic counselors, epidemiologists, and educators), and saw this as critically important for communicating with their colleagues; this diversity of expertise became important in resourceful sensegiving. The genetic counselors and educators translated complex genomic information to show their public health relevance, while the epidemiologists helped analyze data that demonstrated the public health burden of heritable chronic diseases.

Moreover, leveraging diverse expertise allowed the Genomics Program staff to pursue activities within all three CPHF, as noted by one participant: “this is the reason that we've done very well, [we cannot do] state public health in genomics without doing all three” (Interview 1, Genomics Program Staff, November 2012). She continued, “You need to hire an epidemiologist. And the fact that [we] have two should speak volumes. You need that genetics expertise. So the fact that [we have] hired six board certified genetic counselors speaks volumes” (Interview 1, Genomics Program Staff, November 2012). They did not expect any one person to be able to do all of these things, but instead took a collaborative, team-based approach. And they searched for professionals who were especially adept at translating complex genetic concepts for multiple audiences, both within and outside the DHHS.

3.3.2. Sensemaking

The clinical practice guidelines put forth by various professional bodies about the appropriate or inappropriate use of genetic testing were complex, and at times, conflicting. Having the right experts in the Genomics Program was critical to explaining them and relating them to the broader shift toward EBPH. As one staff member explains, even the oldest and most widely known EBM recommendation—for HBOC screening—“is not a simple message …. [it] is not easy to communicate to people in any way, shape, or form. So … [other state health agencies] weren't ready for that. We were ready only because we have the genetic expertise” (Interview 1, Genomics Program Staff, November 2012).

The Genomics Program also found that they had to mobilize expertise differently to maintain their fluency in genomics and keep up with evolving expert panel recommendations. The CDC's focus on hereditary cancer syndromes after 2008 pushed the state health agency to recruit external partners who could help them design disease-specific programming. At that point, the Genomics Program staff came to rely even more heavily on steering committees, to advise them about what forms of data would be most important to tracking HBOC screening and the utilization of cancer services. As one participant explained, the steering committee included people from:

> … all the clinics that are contributing to the BRCA database as well as a whole ton of other people from the cancer section of the state [health agency] or from Medicaid. People who work at health plans around the state that we know who are interested in this sort of thing. (Interview 7, Genomics Program Staff, March 2013)

While Michigan had constituted steering committees since their program's inception, they found that the intensifying pressures for EBPH and proliferation of expert guidelines to support precision public health required them to find partners with more specific expertise, who could help them craft EBPH performance objectives and define relevant outcome metrics for their activities.

5. Discussion

We contend that organizations going through major paradigm shifts need to use a blend of both sensemaking and sensegiving strategies to facilitate adoption of novel technologies; this is especially critical in the context of public health agencies in the US, which are very heterogeneous and draw in professionals from multiple disciplines. Taking the case of the Michigan Genomics Program, we show how a public health organization responded to inter-related environmental jolts that were driven by novel scientific discoveries (genomics and the rise of precision medicine) and concurrent, rising expectations for EBPH. Even though evidence demonstrating the long-term potential of genomics to improve population health was still sparse, the issuance of expert panel recommendations around genomic testing (as in the case of HBOC) still warranted public health action. Acting on a strong expectation that individual-level benefits would also reap population-level impacts, the USPSTF recommended that women with a FHH of breast cancer should be referred for genetic counseling (USPSTF, 2005). While there are still many other unsettled questions about the benefits of public health genomics, in this paper we have examined how ambiguity triggers change within public health organizations. The Michigan Genomics Program needed to modernize their chronic disease programming both to incorporate insights about the genetic bases of chronic disease as well as to respond to calls from within their own profession for a specific, EBPH that was distinct from EBM (Brownson et al., 2009). Such periods of institutional flux highlight the importance of studying organizational change within diverse work settings such as state health agencies.

We find that the Michigan Genomics Program used a combination of sensegiving and sensemaking strategies that legitimized a novel set of technical advances by linking them to a long-recognized professional framework, and that they used hard metrics, especially state-specific surveillance data, to argue that genomics was relevant to chronic disease prevention. These sensemaking and sensegiving activities helped prepared themselves and their colleagues for the heightened scrutiny from funders and policymakers for measurable impacts entailed in EBPH. Our research shows the utility of organizational theory for understanding how evidence-based practice influences contemporary healthcare and health policy.

An important innovation we identified in the Michigan Program is that they engaged in what we refer to as *resourceful sensegiving*, an extension of Wright et al.'s (2000) concept of resourceful sensemaking. Resourceful sensegiving helped them find frames—such as the CPHF—that would resonate with their peers so that they could accept new ideas. In practice, this entailed scanning the horizon to identify genomics applications that had potential to improve morbidity and mortality from common diseases, and to explain and contextualize these discoveries for their colleagues. A critical element of this was to use hard data from state surveillance databases to justify investments of scarce resources in novel genomic technologies and integrate them into chronic disease prevention programming. In this way, the Genomics Program staff used resourceful sensegiving to ready their organization for future advances in genomics that may require action.

In response to rising expectations from their funders for measurable outcomes, the Genomics Program staff again relied on sensemaking frames and practices that centralized the CPHF. This time, however, the aim was different: to help them maintain the rigor of their own programming. Here, the CPHF helped them meet the emerging demands of EBPH, largely through the CPHF's attention to assessment and policy development. Moreover, the Genomics Program staff believed in the absolute necessity of addressing all three elements of the CPHF framework, so that they could maximize their likelihood of improving population health and be able to document the measurable outcomes their funders expected.

We also show how the Genomics Program staff leveraged quantified measures, especially surveillance data and mobilized expertise in pursuit of precision public health. These data practices and expertise were integral to the success of their sensegiving and sensemaking activities. State-specific surveillance data were critical in helping their colleagues understand the local relevance of national recommendations from groups such as the USPSTF. Cultivating diverse expertise among their own staff was important in generating Michigan-specific estimates of the burden of heritable conditions and in communicating with multiple audiences. The cultivation of external partners that followed after 2008, when CDC raised expectations for EBPH practices, helped them continue to use their own expertise while helping them forge new partnerships with disease-specific experts. Leveraging both data and expertise in support of sensegiving and sensemaking frames supported the goal of making these new understandings relevant and actionable.

6. Conclusion

Public health has faced numerous crises in the past two decades, from responding to bioterrorism to containing outbreaks of emerging infectious diseases (Rosner and Markowitz, 2006). While social scientists have studied the ways public health has been disseminated in the developing world, we have paid less attention to the integration of EBPH in the US context. Our research unpacks how broad political and scientific changes may expand public health's jurisdiction or limit a public health response, and shows how these forces play out in a particular state health agency. In this study, we use sensemaking and sensegiving frames to analyze the processes through which the Michigan Genomics Program staff responded to ambiguities in contemporary public health practice. This approach, drawing on tools and concepts from organizational sociology, could help understand other epistemological shifts and transformations in public health.

Beyond the field of public health, sensemaking and sensegiving frameworks could provide insights into the incorporation of evidence-based practice into other multi-professional, multi-sectoral professions. While scholars have examined the adoption of evidence-based practice by specific healthcare professions (e.g., Baker et al., 2010; Satterfield et al., 2009), less is known about its implementation in other settings that resemble public health in having a heterogeneous workforce and a diversified knowledge base (e.g., education, criminal justice, public policy). In such cases, concepts such as sensemaking and sensegiving could prove especially useful to understanding how actors working in heterogeneous environments navigate and manage paradigm shifts and disruptions.

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