PEERING INTO HIDDEN WORLDS: THE PAST AND FUTURE OF LEGAL EPIDEMIOLOGY FOREWORD

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INTRODUCTION

Antony van Leeuwenhoek grew lice in his socks. Curious to learn how many lice would appear, the man who would go on to be called the father of microbiology[1] put two female lice into a clean sock, put it on, tied it tight at the top, and wore it around.[2] After two weeks, he had enough of the two dozen lice that had hatched and feasted on his leg.[3] He stripped off the sock and threw it into the street.[4]

Van Leeuwenhoek's experiment was disgusting on many levels, but it is emblematic of the thirst for knowledge and ingenuity that drove him during a scientific career that spanned more than fifty years. Born in the Netherlands in 1632, a basketmaker's son,[5] Van Leeuwenhoek never received formal scientific training.[6] Nevertheless, he conducted wide-ranging scientific observations and experiments that paved the way for microbiology, microscopy, and bacteriology.[7] Ultimately, his work led to the development of epidemiology and public health[8]—to proof of the microbial theory of disease and subsequently the development of sanitation measures, vaccines,

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1. Edwin Broun Fred, *Antony van Leeuwenhoek: On the Three-Hundredth Anniversary of His Birth*, 25 J. BACTERIOLOGY 1, 2, 14–15 (1933) ("All that is modern in microbiology has been influenced either directly or indirectly by his observations."); Nick Lane, *The Unseen World: Reflections on Leeuwenhoek (1677) 'Concerning Little Animals,'* PHIL. TRANSACTIONS ROYAL SOC'Y B, Apr. 19, 2015, at 1 (noting that Van Leeuwenhoek is "universally acknowledged as the father of microbiology," having discovered both protists and bacteria). *See generally* CLIFFORD DOBELL, ANTONY VAN LEEUWENHOEK AND HIS "LITTLE ANIMALS" (1932) (chronicling van Leeuwenhoek's life and achievements in a comprehensive biography).

2. LISA YOUNT, ANTONI VAN LEEUWENHOEK: GENIUS DISCOVERER OF MICROSCOPIC LIFE 41–42 (2015).

3. *Id.* at 42.

4. *Id.*

5. Fred, *supra* note 1, at 2.

6. *Id.* at 4.

7. *See id.* at 1–2; Lane, *supra* note 1, at 1, 4–6.

8. *See* Howard Gest, *The Discovery of Microorganisms by Robert Hooke and Antoni van Leeuwenhoek, Fellows of the Royal Society*, 58 NOTES & RECS. 187, 187 (2004) (noting that microscopy ultimately became "the backbone of our understanding of the roles of microbes in the causation of infectious diseases"). Epidemiology is the study of "the distribution and determinants of disease in human populations." RAYMOND S. GREENBERG ET AL., MEDICAL EPIDEMIOLOGY 1 (2d ed. 1996).

and antibiotic therapies.[9] From there came the development of policy interventions to disseminate these measures—that is, public health law.[10]

Van Leeuwenhoek and his itchy feet are thus distally but importantly connected to the field of legal epidemiology, or public health law research (PHLR).[11] Further, his work and approach have striking parallels to PHLR—in observation and measurement, scientific testing, and the dissemination of discoveries. This Foreword pays tribute to what has been accomplished in the first decade of legal epidemiology and offers some thoughts about what is yet to come for the field.

I. OBSERVATION AND MEASUREMENT OF PUBLIC HEALTH LAW

At the age of sixteen, Van Leeuwenhoek apprenticed with a linen draper and used a magnifying lens to examine threads in cloth.[12] Captivated by the patterns he saw, he became interested in applying this technology to study the natural world.[13] In the years that followed, he developed techniques to make very small lenses, which he used to make simple microscopes that had remarkably good resolution.[14]

Building on earlier work by Robert Hooke observing cells, Van Leeuwenhoek used his microscopes to generate an array of amazing discoveries: rainwater is teeming with "little animals" (today called protists and bacteria),[15] yeasts are alive,[16] sperm enter eggs to fertilize them,[17] blood circulates throughout the body,[18] maggots hatch from eggs rather than springing to life through spontaneous generation.[19] He spent decades distinguishing and classifying the organisms he found.[20]

Van Leeuwenhoek taught us that in order to really understand something, one first has to truly see it. One must scrutinize all its constituent parts and how they work together. This idea, to me, lies at the heart of legal epidemiology.[21] Among the key achievements of the field in its first decade has been securing acceptance among

9. *See* INST. OF MED., COMM. FOR THE STUDY OF THE FUTURE OF PUB. HEALTH, THE FUTURE OF PUBLIC HEALTH 64–71 (1988); Gest, *supra* note 8, at 187, 198.

10. *See* INST. OF MED., *supra* note 9, at 64–71.

11. Public health law research is defined as "the scientific study of the relation of law and legal practices to population health." Scott Burris et al., *Making the Case for Laws That Improve Health: A Framework for Public Health Law Research*, 88 MILBANK Q. 169, 171 (2010) [hereinafter Burris et al., *Making the Case*].

12. Fred, *supra* note 1, at 2–3.

13. *Id.* at 3.

14. Gest, *supra* note 8, at 192; Lane, *supra* note 1, at 1, 7.

15. Fred, *supra* note 1, at 9.

16. *See id.* at 9.

17. Gest, *supra* note 8, at 192.

18. Douglas Anderson, *Still Going Strong: Leeuwenhoek at Eighty*, 106 ANTONIE VAN LEEUWENHOEK 3, 16 (2014).

19. Gest, *supra* note 8, at 192.

20. *See* Lane, *supra* note 1, at 1 (mentioning as among the questions that drove Van Leeuwenhoek, "where did this multitude of tiny 'animals' come from, why such variety in size and behavior; how to distinguish and classify them?").

21. Legal epidemiology has been defined as "the scientific study and deployment of law as a factor in the cause, distribution, and prevention of disease and injury in a population." Tara Ramanathan et al., *Legal Epidemiology: The Science of Law*, 45 J.L. MED. & ETHICS 69, 69 (2017).

researchers and policymakers for the idea that the adoption and diffusion of laws is a phenomenon that can and should be surveilled and measured.

The development of the field over the past decade has given us both the drive and the tools to closely observe and measure the law. Appreciating complexity and heterogeneity in the law is central to the work of legal epidemiology, as is "identifying and measuring legal variables" to characterize that complexity.[22] This process helps "break[] down complex legal processes into discrete and understandable stages" that researchers can study.[23]

To accomplish the task of decomposing the law into parts for study, researchers needed a toolkit. For that reason, much of the first decade of the field was devoted to creating tools: datasets derived by coding elements of laws, standard operating procedures for creating these datasets, analytical methods appropriate for different tasks, and money to activate these tools in research projects. Generating these resources created the infrastructure for the discovery and application of new knowledge.[24] These tools, especially the more than one hundred legal datasets now available from the Center for Public Health Law Research,[25] enable us to reveal structures and activity "that had always been there, everywhere."[26] The methods developed to encode laws into variables that enable quantification and modeling quickly became the gold standard in the field.[27]

Measuring the law is by no means simple. Even a single statute can be an extraordinarily complicated series of interwoven parts, and the law touches any given area of health in dozens, even hundreds, of ways. Coders may find that laws require considerable interpretation to deal with vagueness and enable categorization.[28] The law's fluidity compounds this challenge. As the law evolves, it seems to constantly squirm out of one's grasp. Van Leeuwenhoek devised a way to glue a spider on its back so he could use tweezers to draw out a thread from its body[29] and designed a device that held a live

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22. *Identifying and Measuring Legal Variables*, CTR. FOR PUB. HEALTH L. RES., http://publichealthlawresearch.org/method/identifying-and-measuring-legal-variables [https://perma.cc/49NY-P57] (last visited May 1, 2020).

23. *Theory & Methods*, CTR. FOR PUB. HEALTH L. RES., http://publichealthlawresearch.org/theory-methods [https://perma.cc/PP3P-TSQ9] (last visited May 1, 2020). *See generally* SCOTT BURRIS ET AL., THE NEW PUBLIC HEALTH LAW: A TRANSDISCIPLINARY APPROACH TO PRACTICE AND ADVOCACY (2018).

24. *See* Scott Burris & Evan Anderson, *The Challenges of Quantitative Public Health Law Research*, 39 AM. J. PREVENTIVE MED. 99, 99 (2010) ("The scientific collection of legal data is a precondition for epidemiologic or behavioral research in which law is the independent variable. Reducing legal text into quantifiable dimensions or categories facilitates statistical analysis. Scientific methods of coding can add rigor and credibility to the classification and comparison of legal texts."); Jennifer K. Ibrahim et al., *Supporting a Culture of Evidence-Based Policy: Federal Funding for Public Health Law Evaluation Research, 1985-2014*, 23 J. PUB. HEALTH MGMT. & PRAC. 658, 661–64 (2017) (noting that investments in building legal datasets have positively impacted the quality and rigor of public health law research).

25. THE POLICY SURVEILLANCE PROGRAM: A LAWATLAS PROJECT, http://lawatlas.org/ [https://perma.cc/T5SY-XXRD] (last visited May 1, 2020).

26. Anderson, *supra* note 18, at 25 (describing Van Leeuwenhoek's microscopes).

27. For a discussion of the consensus around these methods, see, for example, David Presley et al., *Creating Legal Data for Public Health Monitoring and Evaluation: Delphi Standards for Policy Surveillance*, 43 J.L. MED. & ETHICS SUPPLEMENT 27, 28–31 (2015).

28. *See, e.g.*, Burris & Anderson, *supra* note 24, at 99–100 (discussing the example of determining whether recreational user statutes apply to schools).

29. YOUNT, *supra* note 2, at 43.

eel still long enough to observe its circulating blood under magnification.[30] Alas, we cannot quiet our eels in PHLR. But through the development of policy surveillance methods, we have found ways to measure and account for wiggles in the law over time.[31]

The result of all this observing, measuring, and categorizing is that researchers are able to help lawmakers shift from asking *whether* they should adopt a particular type of law to asking *which variety* of that type of law will get the best results. For example, we can advise not simply that prescription drug monitoring laws in general are helpful but that they are most effective when they contain a specific bundle of features, such as requirements that physicians query the system and house the system within a department of health.[32] One benefit of this shift in focus is that lawmakers are more likely to get it right upon initial adoption of a law. Another is that those who do not get it right the first time learn how subsequent tweaks may dramatically improve the results. Whereas previously a law that failed to produce good results might have been dismissed as having been premised on a bad idea, today it is possible to distinguish bad ideas from good ideas that were suboptimally executed. This ability brings policymaking closer to the ideal of an evidence-based lifecycle, in which initial legal experimentation is followed by effect testing, policy refinement, and broad dissemination.[33]

II. TESTING THE EFFECTS OF LAW

In his efforts to better understand natural phenomena, Van Leeuwenhoek not only observed but also tested. He devised experiments to test the effects of heat on bacteria and to grow bacteria in a nutrient medium in a controlled fashion.[34] These experiments paved the way for Louis Pasteur's work and the process of pasteurization.[35] In conducting his experiments, Van Leeuwenhoek "held and practiced the values of empiricism, objectivity, and openness."[36] He was meticulous in conducting his tests and documenting his methods.[37]

Legal epidemiology, too, is focused on "description, explanation, and prediction."[38] From an early stage, the field has embraced a wide range of methods of empirical

30. Anderson, *supra* note 18, at 16.

31. *See* Scott Burris et al., *Policy Surveillance: A Vital Public Health Practice Comes of Age*, 41 J. HEALTH POL. POL'Y & L. 1151, 1160 (2016) [hereinafter Burris et al., *Policy Surveillance*] (noting that policy surveillance provides information about trends in public health laws over time).

32. Rebecca L. Haffajee et al., *Four States with Robust Prescription Drug Monitoring Programs Reduced Opioid Dosages*, 37 HEALTH AFF. 964, 965 (2018).

33. Michelle M. Mello & Kathryn Zeiler, *Empirical Health Law Scholarship: The State of the Field*, 96 GEO. L.J. 649, 668 (2008); *see also* Burris et al., *Making the Case*, *supra* note 11, at 170 ("The responsible use of law as a tool for improving public health requires a commitment to the pursuit and consideration of scientific evidence when possible.").

34. Fred, *supra* note 1, at 11.

35. Anderson, *supra* note 18, at 19; Fred, *supra* note 1, at 1, 11. For details of work in early bacteriology and its relationship to the rise of public health, see Frederic P. Gorham, *The History of Bacteriology and Its Contribution to Public Health Work*, *in* A HALF CENTURY OF PUBLIC HEALTH 70–90 (Mazÿck P. Ravenel ed., 1921).

36. Anderson, *supra* note 18, at 19.

37. Lane, *supra* note 1, at 4.

38. Burris et al., *Making the Case*, *supra* note 11, at 172.

investigation, including both qualitative and quantitative approaches.[39] Early work communicated how the field could apply these diverse methods to investigate several key questions: "[T]he effect of a legal intervention on health outcomes"; "factors influencing the likelihood that public health laws are adopted"; how laws are implemented; and "specific mechanisms through which the law affects environments, behaviors, or health outcomes."[40]

Whatever the methodology, the field has demanded the highest standards of rigor and adherence to the scientific method.[41] The insistence on rigor and the use of quality assurance mechanisms—such as protocols, research teams with multidisciplinary expertise, and peer review—are among the great accomplishments of the field to date. When the field was born, scholars within the legal academy were concerned that the explosion of interest in empirical legal studies had outpaced the training of legal scholars in empirical methods, leading to research of uneven quality.[42] "[S]imple descriptive studies, nonsystematic qualitative work, and overly simplistic regression modeling [were] common . . . ."[43] So were sophisticated econometric studies that, because the investigators did not understand the real-world health issues and health-care settings they were studying, posited causal attributions and mechanisms of effect that lacked face validity.[44]

In no small measure because of the guidance and resources that the Center for Public Health Law Research and the field's early leaders provided, and the success in attracting researchers from a broad range of disciplines to funding opportunities, today sophisticated, well-informed PHLR is the norm, not the exception. The field will continue to grapple with problems of causal inference in observational studies and would benefit from greater attention to how methodologists in adjacent fields such as epidemiology are innovating to address that problem. It will also continue to face the challenge of how to fund the excellent, but expensive, multi-investigator teams conducting these sophisticated studies. Nevertheless, great progress has been made in elevating analytical methods in the field.

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39. *Id.* at 173 (listing "[f]ormal decision analyses, simulations, econometric analyses, laboratory and social experiments, survey, interview, and focus-group studies, systematic reviews, and meta-analyses" as legal epidemiological methods, along with "legal research to systematically and reproducibly collect, classify, and quantify laws and judicial decisions for analytic purposes").

40. *Id.* at 180.

41. *See, e.g.*, Burris & Anderson, *supra* note 24, at 99 (emphasizing that "scientific values of reproducibility and transparency, and scientific tests of validity, should be met" in PHLR).

42. Burris et al., *Making the Case*, *supra* note 11, at 191; *see also* Burris & Anderson, *supra* note 24, at 100 (criticizing early work for nontransparency about methods and contrasting a contemporary work with a detailed methods description).

43. Burris et al., *Making the Case*, *supra* note 11, at 193.

44. *Compare* Jonathan Klick & Joshua D. Wright, Grocery Bag Bans and Foodborne Illness (Inst. for Law and Economics, Research Paper No. 13-2, 2012), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2196481 [https://perma.cc/8D9P-CQFJ] (concluding, in an empirical study, that a ban on plastic grocery bags and subsequent substitution of reusable bags was associated with increased emergency room admissions related to bacteria), *with* Memorandum from Tomás J. Aragón, Health Officer, Cty. of S.F., Dep't of Pub. Health, to Eileen Shields, Pub. Health Info. Officer, Cty. of S.F., Dep't of Pub. Health (Feb. 10, 2013), http://blogs.berkeley.edu/wp-content/uploads/2013/02/SF-Health-Officer-MEMO-re-Reusable-Bag-Study_V8-FIN1.pdf [https://perma.cc/U9G5-U2TL] (arguing compellingly that the association identified by Klick and Wright was not plausibly causal).

III. DISSEMINATING DISCOVERIES

Van Leeuwenhoek was a basic scientist who was unconcerned with practical applications of his work. However, he was assiduously dedicated to disseminating his discoveries. He published 112 scientific letters in a scholarly journal of the Royal Society.[45] All told, he authored around three hundred and fifty letters in his lifetime,[46] an enviable level of productivity. By inviting esteemed scientists of the day to confirm his observations and providing the information necessary for others to replicate his observations, he engaged in an early form of peer review.[47]

Ensuring that research is widely disseminated and has practical impact has been a central focus of building the field of PHLR. From the beginning, even as leaders in the field delineated the boundaries of the field and the core of its methods, they gave thought to how to ensure that research results reached and were comprehensible to policymakers. Encouraging researchers and policymakers to focus on highly salient topics was another preoccupation because work is more likely to be noticed and used when the "so what?" question does not arise. This focus inspired work to define "critical opportunities" for public health law that have three characteristics: (1) there is a problem of great public health significance; (2) the problem is causally related to behaviors, conditions, or other determinants that could plausibly be influenced by the law; and (3) there exists a legal intervention that is plausibly effective and politically feasible.[48] These criteria themselves are not controversial, but it is a shift from the norm to suggest that policymakers should systematically apply a set of decision criteria in setting policy agendas.[49]

Growing the impact of PHLR has also meant growing the size of the field. Money has been critical to this effort; in particular, generous funding from the Robert Wood Johnson Foundation provided grants to more than eighty teams and supported the publication of nearly three hundred articles.[50] Training has also been important. The Policy Surveillance Program has trained more than six hundred people in methods of scientific legal mapping.[51] In addition to legal datasets, two textbooks and a wide array of other open access methods resources are available to the public.[52]

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45. Lane, *supra* note 1, at 7.

46. Anderson, *supra* note 18, at 19. However, Van Leeuwenhoek never described his microscopy methods (e.g., lens grinding and microscope construction). He guarded these secrets carefully and, in part because of that, the world moved from single-lens to compound microscopes. Gest, *supra* note 8, at 197–98. Robert Hooke is widely credited as the inventor of the microscope as we know it. *Id.* This is an object lesson in the importance of disseminating methods as well as findings.

47. *See* Anderson, *supra* note 18, at 18.

48. Michelle M. Mello et al., *Critical Opportunities for Public Health Law: A Call for Action*, 103 AM. J. PUB. HEALTH 1979, 1979–80 (2013).

49. *Id.* at 1985.

50. *Celebrating 10 Years of Legal Epidemiology: A Note of Thanks*, CTR. FOR PUB. HEALTH L. RES., http://phlr.org/10years [https://perma.cc/5CLB-BKK3] (last visited May 1, 2020).

51. *Id*. "Policy surveillance is the ongoing, systematic collection, analysis, and dissemination of information about laws of health importance." Scott Burris et al., *Better Health Faster: The 5 Essential Public Health Law Services*, 131 PUB. HEALTH REP. 747, 751 (2016) [hereinafter Burris et al., *Better Health Faster*] (citing Burris et al., *Policy Surveillance*, *supra* note 31).

52. *Celebrating 10 Years of Legal Epidemiology: A Note of Thanks*, *supra* note 50.

Finally, dissemination efforts have focused on forging strong connections between researchers and policymakers to ensure that knowledge reaches its key audience. Wisely, the field has not relied solely on researchers to conduct translational work. Although the work of translation is never finished, durable structures are in place to nurture partnerships with policymakers. Among these are the Network for Public Health Law and the Centers for Disease Control and Prevention's Public Health Law Program, both of which provide legal technical assistance and resources to public health officials, and ChangeLab Solutions, which translates evidence about what works in state and local public health law into accessible toolkits and model laws.[53] These groups have helped ensure that research reaches and is understandable to those who can put it into action.

IV. TAKING STOCK OF OUR PROGRESS

Van Leeuwenhoek labored in a time without public health law, indeed without much that is recognizable today as public health measures.[54] There were no national health policies, due to a lack of both scientific knowledge and administrative structures to support public health lawmaking.[55] It was not until the late nineteenth century that Pasteur and others proved that bacteria caused infectious diseases,[56] creating momentum for the sanitary reform movement and illuminating avenues for the development of vaccines and antibiotics.[57]

Van Leeuwenhoek, in contrast, lived in the age of the plague before scientists understood how the disease was transmitted. He had chronic diarrhea.[58] He lost four of his five children in childhood,[59] at a time when about one in three children died from prematurity, infectious disease, or other causes before the age of five.[60] He suffered from the lack of what his work eventually led others to understand and create.

In contrast, a child born in the United States today is cradled in a broad web of public health laws. Medicaid and mandatory private insurance coverage for prenatal and preventive care; newborn screening and vaccination laws; water fluoridation laws; motor vehicle and swimming pool safety standards; Women, Infants, and Children program benefits; school breakfast and lunch programs; paid family leave laws; and countless other laws have created an environment in which children can survive and thrive. In 2017

53. Burris et al., *Better Health Faster*, *supra* note 51, at 749.

54. By the seventeenth century, several European cities appointed public authorities to enforce isolation and quarantine for plague and improve sanitation for water supplies, garbage, and sewage. INST. OF MED., *supra* note 9, at 57. However, such measures were not yet routine. *See id.* at 57–58.

55. *The Middle Ages*, ENCYCLOPEDIA BRITANNICA, http://www.britannica.com/topic/public-health/The-Middle-Ages [https://perma.cc/2WK8-5N6M] (last visited May 1, 2020).

56. *See* INST. OF MED., *supra* note 9, at 63; *see also id.* at 58–59 (describing "the great sanitary awakening," the realization that infectious disease was caused by filth—that is, by bacteria and other microorganisms transmitted through improperly managed waste and contaminated water).

57. *See id.* at 63–71.

58. Anderson, *supra* note 18, at 24.

59. DOBELL, *supra* note 1, at 28.

60. Kenneth Hill, The Decline of Childhood Mortality 7–8 (1995) (unpublished manuscript), http://citeseerx.ist.psu.edu/viewdoc/download;jsessionid=AC9162D7FA5F3903BE48383CC8981A0F?doi=10.1.1.613.4151&rep=rep1&type=pdf [https://perma.cc/TRC7-VKW2]. This child mortality figure is derived from data from Sweden and the United Kingdom, which are the best available data for seventeenth-century Europe. *See id.* at 7.

the infant mortality rate in the United States was about 5.7 out of 1,000, and the child mortality rate for ages one to four was about 5 out of 20,000.[61] To be sure, these health gains still compare unfavorably to other industrialized nations and are unequally distributed across racial groups.[62] Enormous work remains to ensure health equity in the law and in lived experience. But the arc of progress is unmistakable.

Also unmistakable is the contribution of public health law to each and every one of the major public health triumphs of the twentieth century.[63] Among the remarkable successes in public health law are the spread of tobacco control laws over industry opposition and the development of evidence-based laws and regulations to reduce the incidence and lethality of motor vehicle crashes.[64] PHLR has played a key role in helping the public understand these success stories.

There are many pioneering thinkers and supporting organizations to thank for the progress the field has made. We should particularly acknowledge the leadership of Professor Scott Burris. In partnership with champions at the Robert Wood Johnson Foundation and other thought leaders, he articulated a vision for the new field of PHLR, and in the decade since he has thrown himself into making it happen. His contributions have been heavily intellectual but also practical: he has led efforts to bring tools and resources to others who can help move the ball down the field. He has nurtured the intellectual community and thought long and hard about the strategy for ensuring that our work has the greatest possible impact. Although he is generous, I do not believe he has done these things out of altruism. Rather, like Van Leeuwenhoek, he has "a craving after knowledge."[65] As a commentator said about Van Leeuwenhoek, Professor Burris's legacy is "[h]is exhilaration in discovery, combined with a fearless and surefooted interpretation of unknown vistas."[66]

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61. *See Infant, Child, and Teen Mortality*, CHILD TRENDS (May 8, 2019), http://www.childtrends.org/indicators/infant-child-and-teen-mortality [https://perma.cc/7Q8K-C5S3].

62. NAT'L ACADS. OF SCIS., ENG'G & MED., VIBRANT AND HEALTHY KIDS: ALIGNING SCIENCE, PRACTICE, AND POLICY TO ADVANCE HEALTH EQUITY S-2, S-3, 1-3, 1-11 (Jennifer E. DeVoe et al. eds., 2019); *cf.* Jennifer Karas Montez, *Policy Polarization and Death in the United States*, 92 TEMP. L. REV. 889 (2020) (discussing the U.S. longevity disadvantage relative to other high-income countries).

63. *See* Ctrs. for Disease Control and Prevention, *Ten Great Public Health Achievements—United States, 1900-1999*, 48 MORBIDITY & MORTALITY WEEKLY REP. 241, 241 (1999) [hereinafter CDC, *1999*]; Ctrs. for Disease Control and Prevention, *Ten Great Public Health Achievements—United States, 2001-2010*, 60 MORBIDITY & MORTALITY WEEKLY REP. 619, 619–22 (2011); Anthony D. Moulton et al., *Perspective: Law and Great Public Health Achievements*, *in* LAW IN PUBLIC HEALTH PRACTICE 3, 3–15 (Richard A. Goodman ed., 2d ed. 2007).

64. Scott Burris & Evan Anderson, *Legal Regulation of Health-Related Behavior: A Half Century of Public Health Law Research*, 9 ANN. REV. L. & SOC. SCI. 95, 97–100, 103–04 (2013); Burris et al., *Better Health Faster*, *supra* note 51, at 747; CDC, *1999*, *supra* note 63, at 242–43. *See generally* Shelley A. Hearne & Katrina Forrest, *Shifting from Problem Identification to Problem Solving: CityHealth as an Accountability and Solution Driving Tool for Governmental Entities*, 92 TEMP. L. REV. 851 (2020) (discussing the widespread implementation of PHLR-identified, evidence-based policies throughout the United States).

65. Lane, *supra* note 1, at 1 (quoting Letter from Antony van Leeuwenhoek (June 12, 1716)).

66. *Id.* at 7.

V. THE NEXT TEN YEARS

PHLR's agenda for its second decade should focus on two things. First, we should continue to improve our methods for studying the epidemiology of public health law. I suspect randomized experiments will always be a luxury this field is not afforded, but like Van Leeuwenhoek, we should constantly strive to improve the precision and accuracy of our observations of phenomena in the world.

This quest requires the continued accretion of legal datasets. It also requires staying at the cutting edge of the application of newly developed analytical methods. This is no easy task given the pace of development. "Synthetic controls," "machine learning"—these terms had no meaning at the time that most researchers in the field of legal epidemiology were trained. The field will be dependent upon the "young guns" to refresh and invigorate our methodological approaches. But as always, we will approach problems with an open-mindedness to the potential utility of new methods.

My hope is that as we move forward, we will no longer confine our aspirations to staying at the leading edge of historically dominant methodological fields like econometrics but will begin to think of ourselves more broadly as data scientists. This shift not only opens up new analytical vistas but also the possibility of exploring relationships in very large health datasets. Machine learning holds the promise of unlocking the "legal information [that] remains trapped in text files and pdfs, . . . excluded from the universe of usable data," as Burris and colleagues described.[67] Rather than using human coders to code a limited set of features of statutes, could we parse and categorize the text of laws comprehensively,[68] designing algorithms to recognize interrelationships among parts of a statute, among different laws, and between laws and health outcomes? With the aid of algorithms, could we leverage massive datasets already in use in health care, health analytics companies, and genomics to learn more about the web of relationships between laws, people's lived experiences, their genetic predispositions, and their health? In other words, is big data legal epidemiology's future?

As we push into new data sources and methods, there will be exciting opportunities to pursue analyses in two areas that have been underrepresented in PHLR to date: cumulative exposure and treatment heterogeneity. Most studies have examined the effect of one type of law and have examined it at the population level. They may control for a person's exposure to other laws, but they do not really study the joint effect of being simultaneously subject to a wide net of laws. Researchers should consider how to better study interactive effects, dose-response relationships, and other aspects of cumulative exposure.

Further, we should give more attention to subgroups. It is, of course, essential to know the population-level effect of a law, in part because that is how we evaluate the "bang for the buck." However, in an age of pronounced and growing inequality,[69]

67. Burris et al., *Policy Surveillance*, *supra* note 31, at 1152.

68. Professor Burris has raised this question in discussing the labor-intensive nature of current legal coding practices. Scott Burris, *Public Health Law Monitoring and Evaluation in a Big Data Future*, 11 I/S: J.L. & POL'Y FOR INFO. SOC'Y 115, 120–24 (2015).

69. For an overview of data on health inequality, see NAT'L ACADS. OF SCIS., ENG'G & MED., *supra* note 62, at 1-19.

distributional effects are also important. Research going forward should include greater focus on heterogeneity in the effects of law on different groups within the population. This emphasis provides a new way of thinking about the bang for the buck: is the law producing big benefits for groups we care deeply about helping, even if the total effect is modest? It further increases the chances of detecting harmful effects on some groups and of redesigning and retargeting laws to achieve our normative goals.

The second line of future work for the field lies in pulling back and thinking more broadly about determinants of health and of successful health policy. Again, early work in our field has, for the most part, been quite narrow. It has sought to isolate and measure the effects of incremental changes in the law. The challenge is how to think bigger and measure bigger. It is the mirror image of Van Leeuwenhoek's preoccupying problem. We can see the law's "little animals" very well: how immunization rates among kindergarteners change when a vaccination exemption law's scope widens or contracts, how hospital-acquired infection rates change when public reporting of infection rates is implemented, and so on. But outside this lens are two juggernauts: the social determinants of health and the changing climate of our planet. Our eyes should be focused on these big problems.

Social epidemiology has been a core part of public health studies for decades,[70] but social determinants have only recently become a focus of legal epidemiology.[71] Leaders in the field quickly recognized that "[a]ctions that actually change pathological social conditions have enormous potential . . . to improve both the level and distribution of health, because they address fundamental causes that find expression in a wide range of ultimate health states reached via a plethora of pathways across the life course."[72] It is notable that a committee of the National Academies of Sciences, Engineering and Medicine concluded in a 2019 report that the major opportunities for improving children's health now lie in reducing child poverty, providing stable and safe housing, reducing toxic environmental exposures, improving early education, and coordinating resources across policy sectors, some of which are quite distal from health care.[73] Exploring laws on these critical issues represents an expansion of the ambit of the legal epidemiology field beyond its initial focus on health care and core public health laws. It means that the field must devote more attention to "incidental public health law"—laws that were adopted with a primary purpose other than health promotion but have important effects on health.[74]

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70. *See, e.g.*, Bruce G. Link & Jo Phelan, *Social Conditions as Fundamental Causes of Disease*, 35 J. HEALTH & SOC. BEHAV. 80 (1995); Geoffrey Rose, *Sick Individuals and Sick Populations*, 30 INT'L J. EPIDEMIOLOGY 427 (1985).

71. Early works in the field include Scott Burris, *Law in a Social Determinants Strategy: A Public Health Law Research Perspective*, 126 PUB. HEALTH REP. 22 (Supp. 3 2011) [hereinafter Burris, *Law in a Social Determinants Strategy*], and Scott Burris et al., *Integrating Law and Social Epidemiology*, 30 J.L. MED. & ETHICS 510 (2002).

72. Burris, *Law in a Social Determinants Strategy*, *supra* note 71, at 24 (citing Link & Phelan, *supra* note 70).

73. NAT'L ACADS. OF SCI., ENG'G & MED., *supra* note 62, at S-6.

74. Burris et al., *Making the Case*, *supra* note 11, at 175; *see also* Kelli A. Komro et al., *Social Determinants of Child Health: Concepts and Measures for Future Research*, 1 HEALTH BEHAV. & POL'Y REV. 432 (2014) (exploring the example of laws relating to family economic security and their impacts on child and family health outcomes).

Part of this study of social determinants must be understanding how the law itself has caused harm, creating and reinforcing social structures that privilege some groups at the expense of others.[75] The law has had a hand in promoting residential housing segregation, racism, income and wealth inequalities, and disparities in health-care access, to name but a few examples.[76] Because the law sometimes causes harm, our field's motto cannot be "The more law, the better." Though scholars and advocates in public health law are often characterized as advocating for greater state involvement in shaping environments and behaviors, sometimes the answer lies in the unraveling of law that is not working as it should. That is likely to be important as we further explore why disparities in health persist.

Climate change also numbers among the critical opportunities for the field, although the issue is just now becoming legitimized as an in-bounds topic for public health. Five years ago, a health law colleague asked, with genuine mystification, "Why is climate change a public health issue?" Today, there is broad awareness of the links between global warming and morbidity and mortality due to food and water shortages, natural disasters, and infectious disease outbreaks.[77] As a marker of how far thinking has come, as august a forum as the *New England Journal of Medicine* recently introduced a new topical focus on climate change.[78] Further research on the health impacts of global warming will undoubtedly reveal an even more devastating set of impacts than is now known.

The possibility—or perhaps, probability—of serious health impacts raises the question of whether our field may be able to help overcome some of the political barriers to adopting laws to arrest climate change by reframing them as health laws. Some lawmakers and voters who do not identify as environmentalists may care deeply about health, particularly the health of today's children. PHLR may be able to help drag climate-oriented laws onto less-contested terrain.

Thus, it is time for careful thinking about how we can better understand the effects of laws on the critical, social, and environmental determinants of health. What do we need to study? How can we do it? How, for example, can we better understand the interactive effects of multiple dimensions of structural disadvantage and vulnerability? How can we scale PHLR globally to take advantage of cross-national variation in legal regimes and to account for the effects of international law?[79] Answering these questions

75. *See, e.g.*, CHANGELAB SOLS., A BLUEPRINT FOR CHANGEMAKERS: ACHIEVING HEALTH EQUITY THROUGH LAW & POLICY 12–13 (2019), http://www.changelabsolutions.org/sites/default/files/2019-04/Blueprint-For-Changemakers_FINAL_201904.pdf [https://perma.cc/5NZN-RQ5T].

76. *Id.*; *see also* Wendy E. Parmet, *Immigration Law as a Social Determinant of Health*, 92 TEMP. L. REV. 931 (2020) (exploring the effects of immigration law on public health); Nicolas P. Terry, *Medicaid and Opioids: From Promising Present to Perilous Future*, 92 TEMP. L. REV. 865 (2020) (discussing how the law has made access to health insurance more difficult for those suffering from opioid use disorder).

77. *E.g.*, *Climate Change and Health*, WORLD HEALTH ORG. (Feb. 1, 2018), http://www.who.int/news-room/fact-sheets/detail/climate-change-and-health [https://perma.cc/YC67-ED72].

78. *Climate Crisis and Health*, NEW ENG. J. MED., http://www.nejm.org/climate-crisis [https://perma.cc/E5SY-LJJ7] (last visited May 1, 2020).

79. *See* Burris et al., *Policy Surveillance*, *supra* note 31, at 1161 ("The benefits of policy surveillance may, if anything, be greater on the global level."); Géraldine Marks-Sultan et al., *National Public Health Law: A Role for WHO in Capacity-Building and Promoting Transparency*, 94 BULL. WORLD HEALTH ORG. 534,

will likely require closer partnerships with colleagues in sociology, political science, and environmental law and science.

At present, the prospects for evidence-based lawmaking to ameliorate health determinants like poverty, discrimination, and global warming seem dim. When our field was born, there was tremendous optimism about the appetite in Washington, D.C., for evidence to inform policy decisions.[80] Today, there is a pronounced turning away from science and expertise. Many researchers have had a "What's the point?" conversation with trainees.

It is not easy to play the long game, but if there is to be evidence-based lawmaking in the future, there must be evidence. There will be demand for this information again in Washington, as there always has been in the states and cities. We must be ready. We will continue to draw inspiration from policy successes at the state and local levels. We draw strength from our intellectual community and shared sense of purpose.

Part of this work must involve recognition of the crisis of distrust in the United States today in the institutions that influence and steward public policy. Governments, large corporations, even universities are often distrusted as not having the interests of the people at heart.[81] Also distrusted are the "elites" that make up those institutions—that is to say, us. Today, voters and activists have a broad range of sources of information that have nothing to do with these institutions and that undermine efforts to communicate facts and promote evidence-based policies. The ongoing battle over vaccination laws is but one example of how distrust and a crowded information space have slowed improvement in states' vaccination laws despite a robust evidence base.

These problems suggest a need for introspection and conversation about how we can effectively communicate our research findings in ways that engender public acceptance. Simply branding them with a university logo or getting a high-profile senator to talk about them will not be sufficient. Sterile presentations of data may not resonate either. We should seek to learn from other fields about how communication methods that are nontraditional for us—for example, storytelling and disseminating messages through ground-level social networks—might be helpful.

In addition to public communication, thought should be given as to how to involve the public in our research. In health services research and clinical research, a movement is afoot to make research not only more "patient-centered" but to collaborate directly with patients in the design and conduct of research projects to ensure that research represents their interests and concerns.[82] There are lessons to be learned there as well.

535–37 (2016) (suggesting that the World Health Organization spearhead a global policy surveillance effort so that laws across different countries can be more readily compared).

80. Burris et al., *Making the Case*, *supra* note 11, at 198.

81. *See, e.g.*, EDELMAN, 2019 EDELMAN TRUST BAROMETER: GLOBAL REPORT 5, http://www.edelman.com/sites/g/files/aatuss191/files/2019-02/2019_Edelman_Trust_Barometer_Global_Report.pdf [https://perma.cc/6WN3-FZR4] (reporting that, in 2019, forty-seven percent of Americans trusted government, forty-seven percent trusted the media, fifty-six percent trusted business organizations, and fifty-six percent trusted nongovernmental organizations).

82. *See, e.g.*, *Our Story*, PATIENT-CENTERED OUTCOMES RES. INST., http://www.pcori.org/about-us/our-story [https://perma.cc/787X-CGUM] (last visited May 1, 2020) (describing Congress's creation of an organization to work directly with patients and other health-care stakeholders to make medical research more relevant to the issues that patients are concerned about).

CONCLUSION

In closing, the field of legal epidemiology is entering its adolescence, which is always a daunting time for parents. But it is also a time of thrilling possibility. In reflecting on Van Leeuwenhoek's work, geneticist Nick Lane commented that because scientists are still arguing about some of the theories to which Van Leeuwenhoek's work gave rise, "we have at best an unreliable map of the land that enchanted" him.[83] But rather than be despondent about all we have yet to know, Lane concluded, "We should rejoice and explore."[84] And so should we. As we mark the tenth anniversary of our field, we celebrate our accomplishments. We thank the visionaries who made them possible. And we bravely pull on our socks to see what more we can learn.

83. Lane, *supra* note 1, at 9.

84. *Id.*