

dressed the nonfinancial burdens associated with malpractice suits, and they were implemented before the proliferation of current payment- and delivery-system reforms, when the individual physician was the natural locus of reform. With the current emphasis on team-based care and with health care organizations taking on the social determinants of health and assuming responsibility for longitudinal outcomes, we believe it makes sense to focus legal accountability at the same

level as accountability for health care costs and outcomes.

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1. Schwartz AL, Cherner ME, Landon BE, McWilliams JM. Changes in low-value ser-

vices in year 1 of the Medicare Pioneer Accountable Care Organization program. *JAMA Intern Med* 2015;175:1815-25.

2. Jena AB, Seabury S, Lakdawalla D, Chandra A. Malpractice risk according to physician specialty. *N Engl J Med* 2011;365:629-36.

3. Jena AB, Schoemaker L, Bhattacharya J, Seabury SA. Physician spending and subsequent risk of malpractice claims: observational study. *BMJ* 2015;351:h5516.

4. Frakes M, Gruber J. Defensive medicine: evidence from military immunity. *Am Econ J Econ Policy* 2019;11:197-231.

5. Kessler DP. Evaluating the medical malpractice system and options for reform. *J Econ Perspect* 2011;25:93-110.

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## Environmental Racism and Climate Change — Missed Diagnoses

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The mother clutches her daughter as the nebulized albuterol permeates the young girl's airways. My eyes dart between the monitor and the child's small, dark-skinned chest as it heaves up and down at an alarming rate. I smile reassuringly, but the mother's eyes begin to well with tears as she recounts her daughter's numerous emergency department (ED) visits and home treatments.

"I have done everything the doctors have asked, and she just keeps getting worse. What am I missing?"

Later, while charting, I review in greater depth the patient's extensive records — far too many for someone so young. Her care teams have all been following the evidence-based guidelines. What are we missing?

In my emergency medicine practice, I often stop at the primary diagnosis, which ignores the critical secondary diagnoses

that make it harder to treat a patient's primary condition. Evidence has linked pediatric asthma exacerbations to exposure to traffic-related and particulate-matter (PM) air pollution, ground-level ozone, and pollen.<sup>1-3</sup> Though it is often impossible to determine with certainty that a given exposure caused a disease in an individual patient, many clinicians would not hesitate to link a history of 50 pack-years of tobacco use to a patient's lung cancer. It is reasonable to view certain environmental exposures in the same way.

More than a decade ago, the American Heart Association concluded that there is a causal relationship between exposure to air polluted by fine PM with an aerodynamic diameter of 2.5  $\mu\text{m}$  or less (PM<sub>2.5</sub>) and cardiovascular illness and death. Last year, the American Thoracic Society documented that long-term air-pollu-

tion exposure causes childhood asthma,<sup>2</sup> and a United Kingdom coroner listed exposure to air pollution as a cause of death in a 9-year-old girl with asthma. As accumulating evidence increasingly links environmental exposures to disease — including the emerging application to health research of detection and attribution methods from climate science — our understanding of contributing diagnoses needs to evolve. There is already a code for air-pollution exposure (Z77.110) in the *International Classification of Diseases*.

Recognizing that exposures to air pollution, ground-level ozone, and pollen are key secondary diagnoses that may be pertinent to my patient, I look up her home address. Suddenly, I am ashamed of missing an additional diagnosis a layer below these exposures: environmental racism. A subtype of structural racism, environmental racism includes the use of

racist practices in determining which communities receive health-protective infrastructure, such as green space, and which receive health-harming highways and industrial complexes.

My patient's home is in a neighborhood that was previously redlined — a now-outlawed racist housing practice that supported segregation and limited the economic opportunities available to Black families — and in very close proximity to a highway. She has therefore been chronically and disproportionately exposed to high levels of traffic-related air pollution from the combustion of fossil fuels.<sup>4</sup> Today, many communities that were subject to redlining are hotter than nonredlined communities,<sup>5</sup> in part because of a dearth of green space and a plethora of human-made materials, such as asphalt, that create an urban heat-island effect — a problem that is pertinent to my patient, given the recent extreme spring heat.

Heat has implications for exposure to ground-level ozone, which is generated from a chemical reaction of air pollutants with heat and sunlight. Climate change, as a quintessential threat multiplier, is definitively increasing the intensity and frequency of extreme heat — as outlined in the latest report from the International Panel on Climate Change — with some observed heat events extremely unlikely to have occurred without it. Pollen levels in our city had been high, and climate change is intensifying pollen seasons, with implications for pediatric ED visits due to asthma.<sup>3</sup> Climate change is thus an increasingly common secondary diagnosis that is almost invariably missed by clinicians.

Suddenly, the albuterol and corticosteroid treatments feel like band-aids on a bullet wound. No matter what her mother or clinicians did, my young patient's physical environment would continue to make it nearly impossible to mitigate her disease. We closely monitor the vital signs that are important for patient care, but I had never considered a patient's address to be one of them.

Diagnosis, of course, dictates treatment. Yet even as I intellectually reckon with a new secondary diagnosis of environmental racism, the treatments it mandates fall outside my usual toolbox.

When an error like a missed diagnosis occurs, safety protocols require a standardized review process that includes analysis of the larger system. But this process is never started if the missed diagnosis is not acknowledged.

Environmental racism and climate change are complex, interconnected, system-level challenges. For busy health professionals, it may seem overwhelming to consider tackling challenges that often seem peripheral to clinical practice. Yet they directly and indirectly contribute to individual-level health harms, even if we are not currently diagnosing them. They threaten the very mission of the medical community — to equitably prevent harm, improve health, and save lives.

Our charts outline our medical decision making, in which we translate complex issues into detailed problem lists and plans. Complex vulnerability profiles for systemic harms that worsen health, such as environmental racism, can also be broken down into three components that can be targeted by interventions: susceptibility, exposure, and ability to adapt.

Although people's inherent characteristics, such as age, can confer increased susceptibility, susceptibility also stems from preventable coexisting conditions. Environmental racism contributes to disproportionate exposure of people of color to PM air pollution from nearly every source of emission, independent of factors such as geography and income.<sup>4</sup> This unequal exposure contributes to increased risk for multiple conditions, including asthma,<sup>1,2</sup> and the aforementioned increased exposure to extreme heat<sup>5</sup> can cause a range of cascading health harms.

The human ability to adapt is a vital mechanism for protecting people from increased susceptibility and exposure. Health care coverage and access to high-quality care are critical to such adaptation. Yet the latest report from the Agency for Healthcare Research and Quality shows significant disparities in access and quality measures affecting Black, Indigenous, and people of color (BIPOC) communities.

Although addressing susceptibility, exposure, and adaptability may barely scratch the surface of complex, systemic issues such as environmental racism and climate change, it can start to make these diagnoses approachable. It is also essential, however, to find ways to facilitate incorporation of these concepts into our clinical practice. For example, patients' detailed environmental exposure profiles, based on their home address, could be integrated into the electronic medical record to inform treatment plans. An indication of the environmental risk level could appear in the record next to the vital signs. In addition, to improve patients' ability

to adapt, prescriptions for home weatherization and air-filtration systems could be made as common as those for albuterol and widely covered by health insurance. Patients can also be educated regarding smartphone or computer apps that report PM, ozone, and pollen levels and can use them to guide behavior.

My encounter with the young girl with asthma, like many I have had since, reinforced my sense that it's my fundamental responsibility as a doctor to address larger systemic issues — even if the decisions leading to the harm are occurring outside the health system. It has never been more important to recognize that upstream policy decisions have long-lasting health and equity ramifications. Policy, combined with other innovations that reimagine our system, can be

used to protect instead of harm. We can capitalize on the opportunity to address these enormous, interrelated challenges simultaneously, with interconnected solutions driven by evidence. Transitioning away from fossil fuels, for example, will address both climate change and air pollution, which are primarily driven by this same root cause.

Collectively, we can respond to the mother's plea. Identifying the missed diagnoses and implementing the correct treatments, both downstream and upstream, is our responsibility. Our band-aids are no longer sufficient.

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1. Brumberg HL, Karr CJ, Council on Environmental Health. Ambient air pollution: health hazards to children. *Pediatrics* 2021; 147(6):e2021051484.
2. Thurston GD, Balmes JR, Garcia E, et al. Outdoor air pollution and new-onset airway disease: an official American Thoracic Society workshop report. *Ann Am Thorac Soc* 2020;17:387-98.
3. Neumann JE, Anenberg SC, Weinberger KR, et al. Estimates of present and future asthma emergency department visits associated with exposure to oak, birch, and grass pollen in the United States. *Geohealth* 2019; 3:11-27.
4. Tessum CW, Paoletta DA, Chambliss SE, Apte JS, Hill JD, Marshall JD. PM<sub>2.5</sub> pollutants disproportionately and systemically affect people of color in the United States. *Sci Adv* 2021;7(18):eabf4491.
5. Hoffman JS, Shandas V, Pendleton N. The effects of historical housing policies on resident exposure to intra-urban heat: a study of 108 US urban areas. *Climate (Basel)* 2020; 8:12.

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