Where Does Wastewater-Based Epidemiology Fall in Medical Student Education?

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ABSTRACT: Doctors are well-trained in the collection, analysis, and interpretation of individual stool or urine sample data; however, wastewater-based epidemiology (WBE) combines the excretion of many community members into an anonymous health sample tied to a geographic location. We advocate for the inclusion of WBE in medical education. WBE offers physicians an opportunity to better care for patients with diseases seen at health clinics and doctors' offices, customize and inform treatment, and accept positive results as true positives, backed by the contextual information provided by wastewater findings. It is also a tool to combat biased or misinformed risk perceptions. Medical education should include how to evaluate wastewater information presented, detect inconsistencies, and determine applicability; just as medical students are taught to do with data from other sources.

KEYWORDS: community health, environmental monitoring, global education, medical education, sewer, wastewater-based epidemiology

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Introduction

Wastewater-based epidemiology (WBE) has been used to study a range of infectious diseases and to estimate the consumption of both legal and illegal drugs and pharmaceuticals.[1–3] Recently, public health officials have included WBE in community health discussions.[4–6] The COVID-19 pandemic has provided valuable insights into WBE, and efforts to integrate this knowledge into medical, engineering, chemistry, and biology courses are already underway and could greatly benefit students. Particularly in fields like medicine, incorporating this knowledge can be a complex discussion despite the exciting opportunity to gain a better understanding of community health. While COVID-19 is still a concern, the progress made and the attention drawn by other stakeholders (industries, government, and the community) are noteworthy and can be promising; now is an excellent time to discuss the inclusion of WBE in curricula. Doctors are well-trained in the collection, analysis, and interpretation of individual stool or urine sample data; however, WBE combines the excretion of many community members into an anonymous health sample tied to a geographic location. Simultaneously, healthcare providers seek ways to gather objective, unbiased information about the communities they serve to better understand their individual patients. We advocate for the inclusion of WBE in medical education to fill this niche.

Inclusion of WBE in Medical Courses

Currently, medical students learn about urine and stool samples as one of the many diagnostic tools that can be used to understand a single patient's infectious or gastrointestinal pathology or for example pregnancy diagnosis. If discussed at all, WBE may only be covered in special discussion groups on public or global health as an interesting subject unrelated to patient care. In these settings, WBE is seen as a useful modality for understanding communities and leading to useful research, intervention actions, and policy recommendations. A clear example is global wastewater polio surveillance, which guides vaccination efforts.[7] Yet, the COVID-19 pandemic resulted in a more diverse group of contributors participating in WBE than historically seen, across industries, government, and the community.[8] During the COVID-19 pandemic, public health department chief medical officer leadership began overseeing WBE data use and interpretation to guide health risk mitigation and intervention.[5] These factors contribute to the inclusion of WBE in medical courses, even if medical students do not intend to practice predominantly in public or global health settings. The question is, where does teaching and learning about WBE fit into medical education?

Teaching Diagnostic Stewardship and Epidemiology

We believe that education on the abilities and utility of WBE fits best in teaching diagnostic stewardship and epidemiology, the concept that the right test is ordered for the right patient at the right time. Professionals in the medical field, including not only doctors but also nurses, lack exposure to WBE and its possibilities during their undergraduate studies. WBE offers an opportunity to teach medical students pre-test probability. Knowing the community level of a pathogen should result in a higher awareness of what may be most likely in a patient with correlating symptoms and knowing that a rare pathogen has been detected locally could result in faster recognition of concurrent cases. WBE offers physicians an opportunity to better care for patients with diseases seen at regular clinics, customize and inform treatment, and accept positive results as

true positives, backed by the contextual information provided by wastewater findings.

Physicians can Add Back Community Knowledge

Objective information on pathogens in a community may also be a tool to combat biased or misinformed risk perceptions. With many people's experience of health care being fractioned between home tests, immediate care centers, emergency rooms, hospitals, and individual providers who may or may not live or work consistently in that geographic area, the sense of "what is happening in the community" can be hard for anyone to know and use in practice. Wastewater offers physicians the opportunity to add back that community knowledge. During the COVID-19 pandemic, vulnerable communities experienced inequalities in access to clinical testing.[9] However, wastewater for pathogen detection is quantifiable and geographically defined, and removes the bias of evidence that may underrepresent vulnerable populations by capturing an anonymous sample of community members using a toilet. WBE data needs to be available to physicians, whether through public dashboards[10] or local health departments in a secure portal or through the Centers for Disease Control and Prevention. Education on WBE may also fit into equity initiatives in medical education.

Conclusion

As WBE progresses and the results become more robust and reliable, these community-based, objective data may even become part of the clinical predictive rules that further assist in diagnostic stewardship. Future research is needed to validate the connections between wastewater detection and pre-test probability and to document successful case studies in which WBE information assists in making timely and accurate diagnoses. Beyond enhancing medical physicians' comprehension of pathology information in clinical tests, WBE also equips them with unique insights to mitigate potential exposure to viruses during these tests. Physicians should be taught how to evaluate wastewater information presented, detect inconsistencies, and determine applicability, just as they are taught to do with other sources of data. The inclusion of specific teaching on WBE in medical education will help physicians use this important source of community information in evidence-based practice.

Author Contributions

Bethany Hodge and Rochelle H. Holm conceptualized, drafted, and reviewed all versions of this manuscript.

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