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Precision Medicine and Precision Public Health: Academic Education and Community Engagement

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Precision medicine (PM) approaches are increasingly included in everyday medical practice. Simultaneously, public health leaders advocate for using related methods to establish "precision public health" (PPH). Academic health centers (AHCs) drive the science that enables these innovations and often pioneer putting them into practice. However, the rise of PM and PPH also affects AHC education and community engagement missions. Several salient opportunities were identified.

DEFINITIONS OF PRECISION MEDICINE AND PRECISION PUBLIC HEALTH

The definition of PM is "an emerging approach for disease treatment and prevention that takes into account individual variability in genes, environment, and lifestyle for each person."[1] PM may allow healthcare professionals to tailor prevention, diagnosis, and treatment strategies to each individual's needs. PM is driven by advances in the collection, management, and analysis of large volumes of data through bioinformatics in the "omics" fields, including genomics, epigenomics, transcriptomics, proteomics, and metabolomics.[2]

In 2011, Khoury et al. noted priorities for public health practice in addressing the role of human genomics in improving population health in the *American Journal of Preventive Medicine*.[3] Subsequently, they suggested that socioeconomic and environmental factors, health behaviors, clinical care, and population genetics should be incorporated into public health planning. This approach, termed PPH, would allow public health practitioners to more effectively deliver policies, programs, and services to specific subpopulations, and ultimately improve public health and reduce disparities.[4,5] Most of current applications of PM and PPH go well beyond the field of genetics. Human genetics will not by itself improve population health.

Neither PM or PPH are novel concepts. Physicians have always tailored treatments to specific patient needs, but newer methods allow a marked increase in customization. Moreover, the volume of relevant obtained data may be unmanageable by an individual clinician. The ability to characterize patients with medically relevant data also raises new issues. These challenges have led to educational efforts for providers, patients, and the broader public. Professionals can be empowered in PM through medical curriculum reform, specialist training, and continuing education.[6] The NIH GeneEd and the All of Us Research Program are examples of professional and community education activities.

Similarly, public health practitioners have long used different approaches in subpopulations with varying prevalence of disease. PPH, however, because of the type of data considered, will enable these approaches to be used more effectively. Accelerated access to data drawn from multiple hospital systems could allow faster, better, and cheaper characterization of the spread of antibiotic resistance. These innovations in communications and computational biology will contribute to data-driven healthcare systems.

THE INTERRELATIONSHIP OF PRECISION MEDICINE AND PRECISION PUBLIC HEALTH

Healthcare systems already gather data that are substantially more comprehensive than those available from individual hospitals. Increasingly, routine care adds "omic" data of PM to these databases. Healthcare

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systems also gather sociodemographic, physiologic, and lifestyle data at the point of clinical care. Members of the public generate medically relevant data with apps, sensors, wearables, and portable devices, which are increasingly used in clinical trials.[7] Genomic initiatives in the United Kingdom are generating data that will be available to new health networks via data grids.[8] By combining data from healthcare systems, individuals, and genomic collaboratives, public health practitioners may efficiently craft PPH policies, programs, and services for target populations, which may help prevent disease and reduce health disparities.[9,10]

Individualized medicine and public health approaches, and by extension, PM and PPH, might seem incompatible with one another. The PM approach seeks to protect susceptible individuals whereas the PPH approach seeks to control the causes of disease.[11] However, the same advances that are revolutionizing individual patient care can enhance population health. Evidence-based genetic screenings and preventive interventions are already available for individuals with hereditary breast and ovarian cancer syndrome (*BRCA* mutations), Lynch syndrome (e.g., *MLH1*), and familial hypercholesterolemia.[12] Future cancer screening may model risk based on interactions of genomics with environment (e.g., epigenomics) and lifestyle (perhaps measured with wearables). Early identification of these individuals can lead to evidence-based interventions to reduce risk, detect early disease, and improve outcomes.[10,12]

Using PPH to identify at-risk populations is a critical advance in science but will fail to produce healthier communities unless effective interventions are available.[13] For example, subpopulations have been identified who are most likely to develop obesity, cervical cancer, and HIV, but effective interventions are currently limited at the community level. Advancements in PPH, however, are expected to integrate genomic sciences, community health assessments, and interventions to better address these issues.

ACADEMIC HEALTH CENTERS NEED TO EXPAND EDUCATION ON PRECISION MEDICINE AND PRECISION PUBLIC HEALTH

Through conducting research, team science, and professional education, AHCs play a vital role in preventing disease in communities.[14] Advances in PM and PPH will require expansion of these educational activities, particularly in three areas. First, current curricula for training healthcare and public health practitioners need to specifically address PM and PPH. Because AHCs prepare students to contribute to health care, educators must ensure graduates are ready to practice in the PM era. Healthcare professionals need to understand the basics of newer fields of biology as well as the analytic methods used to draw conclusions from big data resources. Though individual needs of various disciplines differ, AHCs should identify core concepts of PM that all graduates must understand and the information unique to specific trainee groups, recognizing that no discipline will master all aspects of PM.

Second, AHCs need to develop training programs to prepare certain individuals for specialized roles in PM or PPH. This education will include supplemental courses for specialists who need to add these skills to their repertoire and entirely new training programs for new subspecialists, analogous to the emergence of electrophysiologists within cardiology. Finally, clinical programs in PM, informatics, and pharmacogenomics will supplement or parallel genetic counseling programs to train professionals who can optimize patient and frontline providers use of PM.

Efforts should be championed by AHCs to ensure population-wide understanding of PM concepts. The ethical, legal, and social implications related to genomic sciences demand the input from a broad, diverse, and informed lay community.[15,16] Partnering with trusted community stakeholders, showing cultural humility, and providing honest and impartial information are established best practices in community education. However, more-effective techniques are needed to inform patients and communities about benefits and risks of PM, including participating in PM and PPH studies. AHCs should leverage their influence as expert, honest brokers of knowledge to ensure community-wide understanding of the value, benefits, risks, and costs of PM and PPH.

In addition to education, AHCs must manage and integrate diverse PM and PPH data and pursue novel strategies to foster team science, such as the following:

- AHCs within universities might collaborate with schools of public health and departments of computer sciences and informatics on the same campus to optimize PM and PPH impact.
- Data scientists should be educated to value and understand unique aspects of "omics" data mining, so that they can effectively collaborate with biologically oriented scientists.
- Fellowships should be created to provide social scientists with expertise to communicate effectively with PM or PPH scientists and community members.
- AHCs should identify approaches that support collaborations among experts with disparate training,

engaged around specific projects in PM or PPH, across multiple departments and institutions.

ACADEMIC HEALTH CENTERS NEED TO ENGAGE COMMUNITIES AROUND PRECISION MEDICINE AND PRECISION PUBLIC HEALTH

Community engagement is an important responsibility recognized by AHCs. A key question is how to manage the value and benefits of PM for diverse communities. The answer requires input from community members and leaders. AHCs can provide a forum for community input on PPH issues and advocate for policies that ensure that PPH benefits and risks are distributed equitably. They can leverage regional partnerships with public health departments and other government agencies to coordinate community education and develop an integrated data infrastructure.[17]

Community engagement around PM and PPH should be accomplished through open dialogues about technological advances, new tools that promote population health, and the value of community–academic partnerships. The NIH All of Us program advocates for "a changing culture of medical research that engages individuals not just as patients or research subjects but as active partners."[18] Lessons learned from All of Us community engagement efforts can lead to better success of PM and PPH.[19]

Some community members are concerned about PM and PPH. It may be challenging to engage vulnerable communities to participate in PPH. These challenges are created, in part, by conflicts between individual privacy rights and the public good of knowing precise information about individual behaviors, local environmental factors, and genomic data.[20] Some individuals are suspicious about the likelihood that such precise private data will eventually benefit the highest-risk communities. Others aware of PM may associate the term only with cutting-edge screenings and clinical interventions for sick individuals.

Ensuring individuals control of their personal PM information and autonomy in health decision making are essential principles. The same technologies that are advancing PM and PPH will lead to personal health records in which these concerns decrease.[21] Ethical, legal, and social issues such as genetic discrimination, privacy protection, and informed consent should be addressed with affected subpopulations before any related community initiative.[22] Involving local, underserved communities and developing nations is foundational to PM and PPH having a positive impact among vulnerable populations.

The AHCs are urged to portray PM as a field that not only focuses on new individualized treatments but also seeks population benefit through PPH. This integration will demonstrate commitment to using new tools to not only cure rare and hard-to-treat diseases, but also improve health outcomes, ameliorate disparities, and prevent diseases especially in vulnerable communities. For example, using disease-distribution information and geo-spatial modeling, 90% of the disease burden of chikungunya, dengue, yellow fever, and Zika can be addressed by focusing on just 14% of the 50 million square kilometers of global area where *Aedes aegypti* mosquitos transmit these four infections.[23] The needs and concerns of the community must be recognized, and academicians should prove how PM addresses public health issues in ways greater than ever before.[24] PPH might address social structures shaping population health outcomes.[25]

Community engagement should bring the voice of the public to debates around the role of PM and PPH in improving quality of life. Advocates for disadvantaged groups have raised concerns about net benefit of investments in PM and PPH. Community members have commonly been recruited from groups organized around diseases as they tend to recognize the potential benefits of PM and PPH. By including input from diverse communities, AHCs can ensure that the issues of most concern to disadvantaged communities receive the needed attention.

As AHCs have missions of patient care, research, education, and community engagement, they are well positioned to engage diverse audiences and facilitate discussion across interest groups. Thus, AHCs can help their local communities and greater society to build a consensus among a range of viewpoints. The interests of less powerful groups should not be sacrificed to achieve goals that primarily benefit more privileged individuals.

Many years may pass between establishing an effective advancement in PM practice and wide clinical adoption. AHCs can engage the spectrum of stakeholders to ensure that effective aspects of PM and PPH are implemented rapidly and appropriately across populations. Because the clinical groups affiliated with AHCs strive to be learning healthcare organizations, AHCs should ensure that lessons learned are shared with these stakeholders in a virtuous cycle of engagement.

In conclusion, PM and PPH are rapidly advancing, intertwined fields. AHCs need to expand education in these fields to engage diverse communities and to foster individual and population approaches that are precise, safe, and equitable.

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REFERENCES

1. U.S. National Library of Medicine. Genetics home reference: what is precision medicine? https://ghr.nlm.nih.gov/primer/precisionmedicine/definition. Accessed November 3, 2018.
2. Casteneda C, Nalley K, Mannion C, et al. Clinical decision support systems for improving diagnostic accuracy and achieving precision medicine. *J Clin Bioinform.* 2015;5:4. https://doi.org/10.1186/s13336-015-0019-3.
3. Khoury MJ, Bowen MS, Burke W, et al. Current priorities for public health practice in addressing the role of human genomics in improving population health. *Am J Prev Med.* 2011;40(4):486–493. https://doi.org/10.1016/j.amepre.2010.12.009.
4. Vaithinathan AG, Asokan V. Public health and precision medicine share a goal. *J Evid Based Med.* 2017;10(2):76–80. https://doi.org/10.1111/jebm.12239.
5. Khoury MJ, Galea S. Will precision medicine improve population health? *JAMA.* 2016;316(13):1357–1358. https://doi.org/10.1001/jama.2016.12260.
6. McGrath S, Ghersi D. Building towards precision medicine: empowering medical professionals for the next revolution. *BMC Med Genomics.* 2016;9:23. https://doi.org/10.1186/s12920-016-0183-8.
7. Kim J, Ryu B, Cho S, et al. Impact of personal health records and wearables on health outcomes and patient response: three-arm randomized controlled trial. *JMIR MHealth UHealth.* 2019;7(1):e12070. https://doi.org/10.2196/12070.
8. Molnar-Gabor F, Lueck R, Yakneen S, Korbel JO. Computing patient data in the cloud: practical and legal considerations for genetics and genomics research in Europe and internationally. *Genome Med.* 2017;9:58. https://doi.org/10.1186/s13073-017-0449-6.
9. CDC. Precision public health and precision medicine: two peas in a pod. https://blogs.cdc.gov/genomics/2015/03/02/precision-public. Published 2015. Accessed June 14, 2018.
10. Khoury MJ, Bowen MS, Clyne M, et al. From public health genomics to precision public health: a 20-year journey. *Genet Med.* 2018;20(6):574–582. https://doi.org/10.1038/gim.2017.211.
11. Rose G. Sick individual and sick populations. *Int J Epidemiol.* 2001;30(3):427–432. https://doi.org/10.1093/ije/30.3.427.
12. Khoury MJ, Evans JP. A public health perspective on a national precision medicine cohort: balancing long-term knowledge generation with early health benefit. *JAMA.* 2015;313(21):2117–2118. https://doi.org/10.1001/jama.2015.3382.
13. Bayer R, Galea S. Public health in the precision-medicine era. *N Engl J Med.* 2015;373(6):499–501. https://doi.org/10.1056/NEJMp1506241.
14. Roper WL, Newton WP. The role of academic health centers in improving health. *Ann Fam Med.* 2006;4(suppl 1):S55–S57. https://doi.org/10.1370/afm.562.
15. McEwan JE, Boyer JT, Sun KY, et al. The ethical, legal, and social implications program of the National Human Genome Research Institute: reflections on an ongoing experiment. *Annu Rev Genomics Hum Genet.* 2014;15:481–505. https://doi.org/10.1146/annurev-genom-090413-025327.
16. NIH National Human Genome Research Institute. The Ethical, Legal and Social Implications Research Program. www.genome.gov/10001618/the-elsi-research-program/#al-1. Accessed November 3, 2018.
17. Edmunds M, Thorpe L, Sepulveda M, Bezold C, Ross DA. The future of public health informatics: alternative scenarios and recommended strategies. *EGEMs Wash DC.* 2014;2(4):1156. https://doi.org/10.13063/2327-9214.1156.
18. NIH, All of Us. Considerations toward a comprehensive genomics strategy: the genomics working group report to the All of Us Research Program Advisory Panel. https://allofus.nih.gov/sites/default/files/gwg_final_report.pdf. Published 2017. Accessed June 18, 2018.
19. Lyles CR, Lunn MR, Obedin-Maliver J, Bibbins-Domingo K. The new era of precision public health: insights for the All of Us Research Program and beyond. *J Transl Med.* 2018;16:211. https://doi.org/10.1186/s12967-018-1585-5.
20. May T. Sociogenic risks- ancestry DNA testing, third-party identity, and protection of privacy. *N Engl J Med.* 2018;379(5):410–412. https://doi.org/10.1056/NEJMp1805870.
21. Abnousi F, Rumsfeld JS, Krumholz HM. Social determinants of health in the digital age: determining the source code for nurture. *JAMA.* 2019;321(3):247–248. https://doi.org/10.1001/jama.2018.19763.
22. Khoury MJ, Iademarco MF, Riley WT. Precision public health for the era of precision medicine. *Am J Prev Med.* 2016;50(3):398–401. https://doi.org/10.1016/j.amepre.2015.08.031.
23. Dowell SF, Blazes D, Desmond-Hellmann S. Four steps to precision public health. *Nature.* 2016;540(7632):189–191. https://doi.org/10.1038/540189a.
24. Ramaswami R, Bayer R, Galea S. Precision medicine from a public health perspective. *Annu Rev Public Health.* 2018;39:153–168. https://doi.org/10.1146/annurev-publhealth-040617-014158.
25. Chowkwanyun M, Bayer R, Galea S. "Precision" public health-between novelty and hype. *N Engl J Med.* 2018;379(15):1398–1400. https://doi.org/10.1056/NEJMp1806634.