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Health equity in the implementation of genomics and precision medicine: A public health imperative

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Abstract

Recent reviews have emphasized the need for a health equity agenda in genomics research. To ensure that genomic discoveries can lead to improved health outcomes for all segments of the population, a health equity agenda needs to go beyond research studies. Advances in genomics and precision medicine have led to an increasing number of evidence-based applications that can reduce morbidity and mortality for millions of people (tier 1). Studies have shown lower implementation rates for selected diseases with tier 1 applications (familial hypercholesterolemia, Lynch syndrome, hereditary breast and ovarian cancer) among racial and ethnic minority groups, rural communities, uninsured or underinsured people, and those with lower education and income. We make the case that a public health agenda is needed to address disparities in implementation of genomics and precision medicine. Public health actions can be centered on population-specific needs and outcomes assessment, policy and evidence development, and assurance of delivery of effective and ethical interventions. Crucial public health activities also include engaging communities, building coalitions, improving genetic health literacy, and building a diverse workforce. Without concerted public health action, further advances in genomics with potentially broad applications could lead to further widening of health disparities in the next decade.

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Conflict of Interest

All authors declare no conflicts of interest.

Keywords

Genomics; Health equity; Precision medicine; Public health genomics

Introduction

Health equity, defined as everyone having the opportunity to be as healthy as possible,[1] has long been a primary goal of public health. Attention to disparities in health outcomes during the COVID-19 pandemic has intensified interest in public health action to address health equity.[2–4] Health disparities affect length and quality of life; rates of disease, disability, and death; severity of disease; and access to health care and treatments. Health equity in genomic medicine can be viewed as "the global applicability of genomic knowledge, fair and even access to genomic services such as testing and counseling, and unbiased implementation of genomic medicine."[4] Health equity in genomics is based on improved understanding of the interaction among biological, social, and environmental factors in disease occurrence.

Recent articles[5,6] have included calls to action for a health equity agenda in genomics and precision medicine. Such calls to action have mostly focused on addressing underrepresentation of minority and ethnic populations in genomic research. For example, this cross-sectional study documents the underrepresentation of racial and ethnic minority groups in precision oncology studies and discusses the need to increase enrollment of participants from diverse racial and ethnic background.[7] Another example is the disparities in research studies for sickle cell disease as compared with other less common genetic disorders, such as cystic fibrosis and hemophilia.[8]

However, to ensure that genomic discoveries can lead to improved health outcomes for all segments of the population, a health equity agenda needs to go beyond basic and clinical research. Advances in genomics and precision medicine have led to an increasing number of evidence-based applications in clinical practice and disease prevention (or tier 1, per the Centers for Disease Control and Prevention 3-tiered classification[9]). Tier 1 genomic applications can improve health outcomes and reduce morbidity and mortality for millions of people with various diseases across the lifespan. Examples[10] of tier 1 genomic applications in clinical practice today include newborn screening, hereditary breast and ovarian cancer, Lynch syndrome, familial hypercholesterolemia (FH), hereditary hemochromatosis, and hypertrophic cardiomyopathy. Although we use tier 1 genomic applications as examples of evidence-based genomic medicine that require public health action, we recognize that issues of health equity in access and implementation apply to thousands of genetic disorders and to precision medicine as a whole.

Disparities in Implementation of Genomic Medicine

Implementation disparities for 3 genetic disorders with tier 1 guidelines—FH, Lynch syndrome, and hereditary breast and ovarian cancer—are summarized in Table 1. For all 3 conditions, the overall implementation of current guidelines is suboptimal in the population at large, but most especially among racial and ethnic minority groups, women, people living in rural communities, people who are uninsured or underinsured, and those with

lower education and income. For example, among breast cancer survivors, non-Hispanic Black women are less likely to have *BRCA* testing than non-Hispanic White women. Lack of testing can be driven in part by lack of discussions with providers about testing. Black women are less likely to have discussions with their health care providers about genetic testing than non-Hispanic White women. In addition, physicians primarily serving minorities are less likely to refer a patient to a genetic counselor or to a genetics center for genetic testing. Lack of testing can affect preventive care, both for individuals and families. Black women have lower rates of risk-reducing mastectomy and risk-reducing salpingo-oo-phorectomy than non-Hispanic White women, and cascade screening rates are lower among Black families with *BRCA* pathogenic variants. Even among those diagnosed, inequities in access to screening and treatments exist, which affect health outcomes. Among those with FH, those in racial and ethnic minority groups, those with lower incomes, and women are less likely to start treatment with PCSK9 inhibitors and more likely to be denied insurance coverage for PCSK9 inhibitors. Asian persons and Black persons are less likely than White persons to achieve optimal low-density lipoprotein cholesterol. Women are also less likely to achieve optimal low-density lipoprotein cholesterol reduction than men.

Access to health care is critically important for the implementation of evidence-based genomics and precision medicine applications. Access to testing and interventions involves a combination of psychosocial and structural factors, including availability, accessibility (eg, ability to get to testing services, have appropriate level of genetics health literacy, and language access), and acceptability (eg, people wanting the test, trusting the institution and provider(s), and perceiving that getting tested as beneficial and consistent with their health beliefs and goals). Barriers to health care differentially affect racial and ethnic minority groups, rural communities, people with disabilities, and people with lower incomes, among others. As a result, access to and utilization of health services and specialty care, including genetic services, are lower among these groups, which can lead to lower rates of diagnosis, suboptimal care, and worse health outcomes.

Public Health Action in Addressing Disparities in Implementation of Genomic Medicine

“Public health is what we do together as a society to ensure the conditions in which everyone can be healthy. Although many sectors play key roles, governmental public health is an essential component.”[52] There are 3 broad themes for government public health action at the intersection of genomics and health equity, based on the core functions of public health—assessment, policy development, and assurance.[53] Health equity is at the center of public health action. A special issue of the *American Journal of Public Health,* “COVID-19, Racism, and Public Health Infrastructure,”[54] sounds the alarm for dealing with the disparate effect of the pandemic on racial and ethnic minority groups and low-income populations. If genomics and precision medicine are to improve health for all, generational inequities embedded in society at large and the US health system have to be acknowledged and addressed. Any success resulting from a siloed equity approach to genomics could be overshadowed by other poor health outcomes unless the underlying determinants of health inequities, such as lack of access to health care, healthy food, air, and water; inadequate

housing; chronic stress; and exposures to environmental toxins are addressed, together with core drivers such as structural racism.

Long-standing health disparities and social inequities led to the articulation of Public Health 3.0, as described in a 2016 Health and Human Services report.[52] The framework sought to revitalize the US approach to governmental public health with strong and diverse workforce, strategic partnerships, sustained funding, specific population-level data and metrics, and foundational infrastructure.

In the context of genomics and precision medicine, we view public health as an important part of the solution in dealing with equity challenges in genomics, just as with other fields of health care. It is important to note that although a focused population health approach to genomics might broaden access to genomic innovations, a public health approach including community engagement will be needed to address issues of trust, many of which are rooted in long-standing community experiences with structural racism.

Current public health practice is not optimally integrating genomics into the essential functions of assessment, policy development, and assurance. Here, and in Table 2, we summarize our vision and opportunities for specific public health actions that can be conducted by the Centers for Disease Control and Prevention and its many partners to help reduce disparities in the implementation of genomics and precision medicine. This framework lays the groundwork for the next steps, including identification of specific goals and measurable outcomes in the design and implementation of specific community-based interventions.

Public health assessment through data modernization and applied research

An important function of public health is to collect real-time data through surveillance and applied research to drive policies, guidelines, and programs. National, state, local, and community-specific data systems are needed to evaluate disparities in genomic application utilization, interventions, and outcomes to inform evidence-based guidelines and implementation of genomic medicine.

Public health is currently undergoing strategic innovation as part of a data modernization initiative[55] by assessing the opportunities for and limitations of new and nontraditional data sources and data science approaches to inform public health decision making. The need for tracking progress and outcomes in genomics and precision medicine is a high priority for action, and novel approaches could increase public health's ability to track health disparities, for example, by using geocoding to better measure area of residence to identify areas of high need and low resources. New and innovative approaches are needed to integrate tracking for genetic disorders into surveillance systems, surveys, claims, and administrative databases. For example, employer-sponsored health insurance claims data were used to track trends and differences in *BRCA1/2* genetic testing and receipt of preventive interventions in women aged 18 to 64 years between nonmetropolitan and metropolitan areas in the United States.[49] The analysis documented the existence of geographic differences in *BRCA* test utilization as a proxy for rural-urban differences in access to care.

Several groups are currently using next-generation tools, such as machine learning approaches, and nontraditional data sources for conducting public health surveillance of genetic disorders. A case in point is the use of the FIND-FH algorithm in health systems.[38] Such efforts need to be expanded for various diseases and cover broader population samples than traditional databases, such as those from employer-sponsored health plans. These approaches may facilitate identification of disparities in diagnosis, interventions, and outcomes and inform programs, practice, and policy.

Another example is the emerging integration of genomics into population-based cancer registries and surveillance systems.[56] Cancer surveillance traditionally is conducted based on tumor anatomic location and histology. However, molecular markers, such as gene expression profiles, can identify heterogeneous subgroups associated with different risk factors, treatment responses, recurrences, and survival patterns. In addition, conducting surveillance for hereditary cancer will allow stratification of reporting and tracking of population cancer incidence, outcomes, and disparities by underlying genetic cause.[56]

In addition to public health surveillance, applied research based on principles of implementation science[57] is needed to evaluate multisectorial interventions (individual, health care providers, health systems, policy interventions) that can facilitate implementation of evidence-based genomic applications and drive uptake of recommended services. These studies would have a special emphasis on communities and subpopulations with the largest gaps in implementation. Until recently, implementation science had not been a strong focus in the genomic research portfolio.[58] Recent initiatives by the National Institutes of Health[59,60] are attempting to leverage implementation science to close these gaps in genomic medicine. Accelerating implementation science can go a long way in identifying best practices for ensuring equity in the implementation of genomic medicine.

Furthermore, there is an important role for social, behavioral, and communication sciences in assessing best approaches for effective translation of genomic discoveries into population health benefits.[61] Such approaches will require consideration and evaluation of multiple systemic and psychosocial factors occurring within and outside health care settings, as well the broader challenges of information diffusion, health literacy, and action in families and communities.[59]

Evidence Synthesis, Guidelines, and Policy Development

Public health leadership is critically needed to establish an evidentiary foundation and guidance for implementing genomic applications to improve health outcomes in all segments of the population. It is imperative to assess the unique challenges of communities negatively affected by social determinants of health, including racism. Public health action is also needed to address policy barriers to effective, widespread implementation and monitoring of genomic applications.

Public health can build on previous successes of genomic evaluation initiatives, such as the Evaluation of Genomic Applications in Practice and Prevention initiative[62] and the ACCE (Analytic validity, Clinical validity, Clinical utility, and Ethical legal and social

implications) framework[63] to develop processes for systematically evaluating evidence on the implementation of tier 1 genomic applications in different communities. Necessary actions include convening methods development and evidence review panels for topics of interest and developing and testing novel evidence synthesis strategies to reduce health disparities. The focus of reviews will be on implementation of science-based evidence regarding how to most effectively use genomics applications that have already been deployed in multiple communities and health systems. Considerations for implementation specific to certain communities and populations negatively affected by social determinants of health should be prioritized. Such evidence synthesis can drive the development of nationally credible, evidence-based implementation guidelines for genomic testing applications tailored to different communities and health care settings to facilitate broader understanding and adoption of evidence-based services.

A specific example of an implementation challenge is the low cascade screening uptake in relatives of affected patients, especially within communities of color. Cascade screening is an important component of guidelines for several tier 1 genomic applications, but its implementation falls short. A recent systematic review[64] assessed barriers to and facilitators of cascade screening. The review identified individual-, interpersonal-, and environmental-level barriers that currently interfere with cascade screening and may be associated with health disparities. At the individual level, the review identified barriers related to demographics, knowledge, attitudes, beliefs, emotional responses of the individual, and attitudes toward relatives. Examples of identified barriers include low income, lack of access to health care, and lack of effective approaches that reach relatives. The review also identified factors associated with communication, support, and dynamics with family members and clinicians, such as communication and language barriers and lack of provider awareness and engagement. At the environmental level, the review identified barriers correlated with accessibility of genetic services, such as cost and insurance coverage. The review identified the need for implementation studies to further investigate these factors and inform future interventions for improving the implementation of cascade testing for genetic disorders in all populations. This systematic review can influence the development of guidelines and recommendations for best practices for implementation of cascade screening in different communities and promote equity in implementation.

To achieve the goal of equitable access to and uptake of genetic tests and services, policy barriers must be overcome. Many people who could benefit from these services are unor underinsured; expanded coverage and adequate reimbursement could help remedy this obstacle, especially among racial and ethnic minority populations, those with inadequate insurance coverage, and those who live in rural areas. Additional obstacles arise from data sharing and privacy policies that complicate the development of interoperable data systems, a critical source of real-world evidence to inform guidelines and enable cascade testing.

An example of an important policy consideration in cascade screening is how the Health Insurance Portability and Accountability Act (HIPAA),[65] considered by some providers to be a barrier to cascade screening, should be interpreted in the context of sharing of genomic information among relatives in different communities, especially those negatively affected by social determinants of health. A recent review[66] analyzed the HIPAA Privacy Rule and

developed multiple scenarios that could inform how HIPAA can be interpreted for patient- and provider-mediated genetic risk notification. This analysis concluded that several forms of patient- or clinician-initiated contact of family members are permissible under HIPAA and consistent with ethical obligations of care to patients and their families. These include direct contacts of patients' adult relatives with patients' permission and direct contact of the relatives' providers. It is important to acknowledge, however, that effective and equitable cascade testing heavily depends on the dynamics of family relationships and that health care providers may not be able to ethically contact relatives without explicit permission of patients. It is crucial to assess how to translate this policy analysis into guidelines and tools among racial and ethnic minority populations to help advance cascade screening for many conditions. Further research will be needed to determine best practices for implementing these guidelines broadly and addressing the specific needs of different communities.

Public Health Assurance: Programs, Resources, and Workforce Development

There is an essential role for public health in addressing health equity in genomics by integrating genomic tools in different community and health care settings. Public health programs in collaboration with communities and health systems could support effective implementation and improve population health outcomes by engaging communities equitably and addressing documented disparities in genomic medicine implementation.

Public health programs can establish exemplar projects and networks for population-level implementation of genomic testing applications that focus on communities that are differentially affected by social determinants of health. Engaging with communities is essential to build trust and tailor approaches to meet specific needs, raise public awareness of genomic applications, and increase uptake. These projects can be integrated into existing community and health care efforts, such as health screening programs, to identify people at increased risk of poor health outcomes associated with hereditary conditions.

Public health can also work with communities to increase access to genetic services, for example, through telehealth. For example, the Maternal and Child Health Bureau of the Health Resources and Services Administration has established 7 Regional Genetics Networks and the National Coordinating Center as part of ongoing efforts to improve the health of populations that are medically underserved.[65] A current emphasis of the network, especially during the COVID-19 pandemic, is to enhance the delivery of genetic services using telehealth resources (telegenetics), an emerging tool to facilitate virtual access to medical geneticists and genetic counselors, especially among rural communities with limited access to genetic services. A recent commentary reviewed the successes and challenges in the implementation of virtual genetics visits during the pandemic and discussed genetic testing considerations in addressing health disparities.[67]

Another example is the ongoing partnership between the Million Hearts initiative and the National Association for Health Centers to improve the use of statin therapy for patients at high risk of heart attack and stroke through an enhanced care process to prescribe statins to as many patients at high risk as possible.[68] An added component of this initiative could

include enhanced methods for finding people at high genetic risk, such as those with FH, and cascade testing of their relatives.

Furthermore, tools and resources for action need to be specific and tailored to health care organizations and communities. Tier 1 genomic application decision support tools for clinical practice will be needed, as well as culturally and community-appropriate educational materials for patients and families. Because family health history is a common risk factor for many conditions, simple family health history tools,[69] including the popular Surgeon General's My Family Health Portrait,[70] could be adapted to different communities and health care organizations to overcome barriers in the identification of genetic disorders and facilitate cascade screening.

Finally, there is an emerging need to build the clinical and public health genomics workforce and increase its diversity. A survey of American Board of Medical Genetics and Genomics board-certified/eligible diplomates in 2019[71] characterized the US clinical genetics workforce to inform workforce planning and public policy development. The survey showed that most genetics specialists work in academic medical centers in major metropolitan areas, leaving many people in rural areas with no or limited access to genetics specialists. In the absence of concerted efforts to increase the number of genetics specialists through enhanced training and enhanced career and salary incentives, the current and future workforce will not meet the increasing patient needs in genomic medicine.[72] Furthermore, the lack of diversity in the genetics workforce hinders its ability to meet the needs of all populations—90% of genetic counselors responding to the survey identified as non-Hispanic White. In public health, there is a paucity of professionals trained in human genomics. In state public health programs, genetics capacity is concentrated almost exclusively in newborn screening programs and maternal and child health programs. A survey conducted by the Council for State and Territorial Epidemiologists[73] revealed that the most state epidemiology positions focused on infectious diseases, with only 0.1% focused on human genomics. Overall, state epidemiologists assessed their state epidemiology capacity in genomics as none to minimal. The COVID-19 pandemic has expanded state and academic capacity in pathogen genomics (see example of a recent initiative[74]), but more effort will be needed before there will be a spillover effect to human genomics capacity.

Concluding Remarks

An ambitious public health agenda is needed now to ensure that the entire population reaps the benefits of genomics and precision medicine. We presented an overall vision and opportunities for selected public health actions (Table 2), but a more in-depth analysis to identify specific goals and measurable outcomes will be needed to design and implement specific interventions tailored to reach persons with genetic disorders in populations and communities experiencing health inequities. Achieving health equity in genomics and precision medicine will depend on strong collaborations with community leaders, patient organizations, professional organizations, academia, health care systems, health care payers, industry, and charitable foundations. A unique and valuable role for public health is to serve as a convener of partners to ensure community engagement that is inclusive and participatory and ultimately helps to accelerate the equitable implementation of genomics

and precision medicine. There is also a unique opportunity to engage social and behavioral scientists in assessing the effect of multiple psychosocial and communication factors on the optimal implementation of genomics and precision medicine in all populations. Finally, it is important to recognize that even though many of the populations with less access to genomics are the same communities with significant negative effects of social determinants of health, genomics will not address disparities that are primarily caused by social determinants.[75] A health equity agenda in genomics should be just one component of an overall health equity approach to health and health care. Any success resulting from a siloed equity approach to genomics would be overshadowed by other poor health outcomes unless the underlying determinants of health inequities, such as lack of access to health care, inadequate housing, and exposures to environmental toxins, are addressed together with core drivers, such as structural racism.

Experience from COVID-19 demonstrated the need to have data collection, systems, and analyses that disaggregate data and make that data accessible to stakeholders, including communities experiencing disproportionate gaps in implementation of genomic medicine. This will require integration of utilization of genetic screening and interventions into electronic health records as well as careful assessment and solutions to privacy and confidentiality concerns associated with data sharing. To ensure that equity approaches are embedded in all stages of implementation planning, engagement of communities is essential for wider implementation of genomic medicine.

We have a real opportunity to get out in front of the emerging field of genomics and precision medicine before the existing disparities widen further as new technologies lead to more evidence-based applications. Many health disparities are deeply entrenched, but as a new field, we have a window of opportunity to address the implementation challenges early on. Because the pandemic has differentially affected subgroups of the population and laid bare the effect of social determinants of health, achieving health equity in the implementation of genomics and precision medicine is more important than ever.

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Table 1

Disparities in implementation of evidence-based guidelines for selected tier 1 genomic applications

	FH	HBOC	LS
Tier 1 recommendation	For those diagnosed with FH, perform cascade testing of first-degree relatives for FH by measuring LDL-C concentration, genetic testing, or both.	Assess risk for women with a personal or family history of breast, ovarian, tubal, or peritoneal cancer or who have an ancestry associated with *BRCA* variants and refer those identified as at risk for genetic counseling and, if indicated after counseling, testing.	Screen tumor tissue from colorectal (and possibly endometrial) cancer using MSI and/or IHC to check for LS. In some cases, genetic testing might be needed to confirm LS diagnosis. Genetic testing to identify pathogenic variants can allow cascade testing to identify family members with FH.
Estimated number of people with condition in the United States	1,300,000	660,000 to 990,000	1,200,000[11]
Prevalence by race/ethnicity	Non-Hispanic White: 0.4% Non-Hispanic Black: 0.5% Hispanic: 0.2%[12]	Non-Hispanic White: 1.5% Non-Hispanic Black: 0.5% Hispanic: 0.4%[13]	Among those with colorectal tumors screened for LS: Non-Hispanic White: 10.4% Non-Hispanic Black: 9.6% Hispanic: 12.6%[14]
Implementation inequities			
Ethnicity/race	Disparities documented by race and ethnicity in • research,[15] registries,[15] and clinical trials,[16] • cholesterol screening,[17] • FH awareness,[16] • age at diagnosis,[15] • variant detection using standard genetic screening,[18,19] • achieving target LDL-C levels,[15] • use of high-intensity statins[15] and PCSK9 inhibitors,[20] and • denial of insurance coverage for PCSK9 inhibitors.[21]	Among breast cancer survivors, disparities documented by race and ethnicity in[22–29] • awareness of *BRCA* testing,[30] • discussion of genetic testing with health care provider, • referrals to genetics specialists and centers, • rates of *BRCA* testing, • time to surgery and chemotherapy, • rates of risk-reducing mastectomy and salpingo-oophorectomy, and • adherence to endocrine therapy.[31]	Disparities documented by race and ethnicity in • referrals for genetic evaluation,[32] • genetic counseling and genetic testing,[33] • sharing of personal or family history, information that affects screening age,[34] • colonoscopy screening at ages 40 to 49 for first-degree relatives of those with colorectal cancer,[35] and • IHC tumor screening of endometrial cancer[36]
Sex	Disparities documented for women in[15,37,38] • research, • age at diagnosis, • likelihood of FH being diagnosed after an ASCVD event, • achieving target LDL-C levels, • use of statins, high-intensity statins, and PCSK9 inhibitors, • maintenance of statin therapy, including during childbearing, side effects associated with statin use, and • denial of insurance coverage for PCSK9 inhibitors.[21]	Men with HBOC are less likely than women to receive implementation of • screening recommendations[39] and • cascade testing in families.[40]	Disparities documented for • rates of LS screening for endometrial cancer compared with colorectal cancer[41] and • uptake of risk-reducing surgery for women with LS in alignment with clinical guidelines.[42]
SES	Disparities documented for SES in • health literacy,[43] • adherence to statin therapy,[44] • initiation of PCSK9 inhibitors,[20] and • denial of insurance coverage for PCSK9 inhibitors.[21]	Disparities documented for Medicaid-insured patients in rates of *BRCA* testing among patients with ovarian cancer.[45]	Disparities documented for SES in age at surgical resection for colorectal cancer.[46]

	FH	HBOC	LS
Rural/urban	Disparities documented for rural areas in • access to specialty care,[47] and • providers reporting difficulty prescribing PCSK9 inhibitors.[48]	Disparities documented in nonmetropolitan areas in[49] • rates of genetic counseling and *BRCA* testing and • breast MRIs for those at increased risk.	Disparities documented for rural areas in LS testing and genetic counseling.[50,51]

ASCVD, atherosclerotic cardiovascular disease; *FH,* familial hypercholesterolemia; *HBOC,* hereditary breast and ovarian cancer; *IHC,* immunohistochemistry; *LDL,* low-density lipoprotein; *LDL-C,* low-density lipoprotein cholesterol; *LS,* Lynch syndrome; *MSI,* microsatellite instability; *SES,* socioeconomic status.

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Table 2

Essential public health services, vision, and selected opportunities to help close the health equity gap in genomics and precision medicine

Continuum of Essential Public Health Services	Opportunities for Implementation of Emerging Genomic Applications Using a Health Equity Lens[a]
Population health assessment	Vision: Toward more precision in measuring disparities in diagnosis, prevention, treatment, and outcomes in emerging genomic applications in different communities
Public health surveillance	Integrate genomics and precision medicine into public health data modernization
Applied and implementation research	Develop and implement a robust community-specific implementation science agenda for genomics and precision medicine in underserved communities
Guidelines and policies	Vision: Toward effective engagement of different communities to drive needs assessment, evidence synthesis, policies, and guidelines
Evidence synthesis	Develop a process for continuous evidence synthesis and prioritization for implementation of tier 1 genomic applications in different communities
National and community-based guidelines	Develop evidence-driven models for coverage and reimbursement, data sharing and learning health systems for different communities
Assurance and capacity building	Vision: Toward achieving learning health systems for implementation of emerging genomic applications in different communities
Model community programs	Develop and implement exemplar pilot projects that facilitate building trust and access to evidence-based genomic applications in different communities
Tools and resources	Develop and validate patient- and community-specific tools and resources for implementation
Workforce development	Integrate genomics into clinical and public health workforce development and focus on diversity and inclusion in recruitment and retention of next-generation professionals

[a]The main focus of a public health genomics agenda is on persons and communities negatively affected by social determinants of health, including racial and ethnic minority groups, people living in rural communities, uninsured or underinsured people, and those with lower education and income.