Summary of Strategic Planning Workshop: Genomics in Medicine & Health
September 26-27, 2019

As part of the National Human Genome Research Institute's 2020 Strategic Planning efforts, the institute hosted a "Strategic Planning Workshop: Genomics in Medicine & Health" on September 26-27, 2019 in Bethesda, Maryland. The workshop's goal was to explore what is needed to implement a vision to integrate genomics into routine medical practice in a way that prevents disease and improves the health of all members of a diverse community by engaging patients, their families and the entire healthcare team in genomic health care. Using the feedback heard from the Strategic Planning town halls, meeting sessions and satellite meetings to date, the workshop organizers drafted the following themes as a starting point for the workshop.

1. Create systems to integrate genomics into everyday clinical and public health practice.
2. Improve processes for routine, high-value clinical genomic testing.
3. Build knowledge bases for predictive genomic medicine in diverse populations.
4. Develop and evaluate genomic prevention and therapeutic strategies in diverse populations.
5. Ensure that genomic health information has maximum utility for all members of the public.
6. Train healthcare providers to integrate genomics into the clinical workflow.

For each of these themes, the workshop addressed barriers and opportunities for implementing genomics into routine healthcare and identified potential projects and opportunities to propel genomic medicine to "the forefront of genomics" in roughly five to ten years' time.

To kick off the workshop, Dr. Heidi Rehm and Dr. Marc Williams gave presentations on the current state of genomic medicine. Dr. Rehm highlighted that genomic medicine comprises discovery, assessment of utility and clinical implementation. Currently, genomic medicine has had many successes in identifying variant/disease associations and has implemented some uses of genomic information into clinical practice. However, evidence of utility and widespread adoption lag behind due to cost, insufficient provider education, incompatible electronic health records, issues with hospital/institutional organization and patient privacy concerns. Dr. Williams focused on the implementation of genomic medicine through diagnosis, pharmacogenomics, oncology and population screening. Today, healthcare providers treat genomic testing results as final, similar to other laboratory test results. Despite the fact that germline DNA does not change throughout the patient's life, the interpretation of variants with clinical significance will change with accumulating knowledge and reanalysis (both as new variants are identified and added to public databases and as patients are referred and reevaluated for suspected genetic diseases). After reviewing the current state of genomic medicine, the workshop delved into the six themes in more detail, with participants sharing their ideas for genomic medicine in 2020 and beyond.

Theme 1: Create systems to integrate genomics into everyday clinical and public health practice
Speakers: Denise Dillard, Latrice Landry, Mike Murray, and Casey Overby Taylor
Moderator: Natasha Bonhomme

Recommendations:
  a. Develop and pilot novel approaches to the implementation of genomics for common diseases in real-world health care systems

b. Support and expand the return of secondary findings from clinical genome and exome sequencing as a model system for population screening.
c. Build population-specific and longitudinal data from participants of diverse ancestries that allows providers to implement and track the utility of genomics.
d. Develop infrastructure for data portability, iterative use and flexibility.
e. Engage diverse communities and change the current genomic medicine system to be more inclusive.
f. Test genomic medicine implementation strategies and develop best practices.

In this session, discussants proposed several ideas related to the question: What is needed to use genomics in medicine and health?
- Implement a network of statewide and state-based participation in genomic medicine learning health systems.
    o Monitor implementation, tracking, and compliance on a state-by-state basis, similar to how the current newborn screening system operates.
- Increase participation from tribal and Indian Health System users by engaging with community members in genomic research and medicine, expanding access to genetic counselors and providers, and maintaining electronic health records.
- Improve genomic literacy through tailored and multifaceted modalities: educate providers on how to deliver genetic risk-informed interventions; communicate with patients through phone calls, video, and eHealth consults. Facilitate the return of secondary findings from clinical genome sequencing.
    o Encourage mechanisms to teach genomic medicine outside research programs – i.e., using mobile technology applications and other technologies that are already publicly available.
    o Develop physician interfaces to educate providers.
- Build infrastructure based on population-specific data and data from participants of diverse ancestries that allows providers to order appropriate genetic testing and translate biomarkers for their patients.
    o Make it a prerequisite to include people who represent all segments of the population in efforts to understand genomic medicine implementation challenges, increase discovery rates, and improve utility.
- Take advantage of the genomic medicine data already collected in NHGRI programs and other longitudinal data.
    o Participants should be tracked across time through their health records
    o There should be interfaces for patients and providers to discuss outcomes
    o Information should be freely transmitted across health systems as patients move across them.

Theme 2: Improve processes for routine, high-value clinical genomic testing
Speakers: Michelle Clark, Amit Khera, Mullai Murugan, and Alicia Zhou
Moderator: Tony Wynshaw-Boris

Recommendations:
a. Develop models that integrate genomic testing with other risk information (family history) for predictive medicine in a clinical setting using electronic health records (EHRs).
b. Communicate next steps after genomic testing clearly in diverse clinical settings, using electronic health records and applications to facilitate communications.

    c.   Track and ensure comprehension, behavior changes and outcomes from genomic medicine.
    d.   Understand behavioral barriers to ordering genetic tests and genomic data and develop approaches to mitigate those barriers.

In this session, discussants identified several ideas related to the question: What is needed to make genomic tests accurate, easy to use and understandable?

- Scale up sequencing technology at the population-level for screening and early identification.
    - o Include sequencing "healthy" and asymptomatic people.
    - o Increase discussion on protective variants, genomic resiliency and refinement of odds ratios and other risk predictors as tools to manage common diseases.
- Develop integrated risk models to predict disease development and progression through preventative genetic screening of asymptomatic individuals, combined with best practices for relaying this information in a clinical setting and integrating genetic data into electronic health records (EHRs).
    - o Include family history and ancestry in risk models and develop counseling recommendations for patients regarding behavioral changes to limit disease risk. Models should also be validated to rely on robust variant annotation and be reassessed throughout the patient's life.
    - o This may require the collection of prospective multiethnic cohorts with clinical phenotypes, genotypes and environmental variables.
- Improve clinical genomic testing in individuals with suspected genetic disease or familial history through EHR implementation; integrate across all health systems; collect evidence and share data across clinical, research and commercial spheres.
    - o Ensure the correct tests are being run for each patient and alert other providers when a genetic test is ordered to reduce duplicative testing and promote use of the results. Consider automated processes for recommending testing.
- Build a rapid and comprehensive precision medicine system for early diagnosis by using rapid genome sequencing, extracting phenotypes, streamlining assays and communication of results, and providing guidance for treatment.
- Create a data format that can link genetic test information and pathology reports in the EHR (beyond an associated PDF/text file) and increased health information exchange through standardized knowledgebases using national standards (such as HL7, FHIR, GA4GH).

Theme 3: Build knowledgebases for predictive genomic medicine
Speaker: Lisa Bastarache, Juan Rodriguez-Flores, Katrina Goddard, and Iftikhar Kullo
Moderator: Gillian Hooker

Recommendations:
    a.   Create a knowledge base of risk alleles from diverse populations.
    b.   Develop knowledge bases from high-throughput assays to determine the functional consequences of variants.
    c.   Establish, evolve and reinforce clinical genomic data standards.
    d.   Improve integration with other clinical information and longitudinally over time.
    e.   Share knowledge, data and resources in a way that honors patient privacy and data use limitations.

In this session, discussants identified several ideas related to the question: What do we need to know to tell any patient their risk of disease, based on genomic testing?

- Create a knowledge base of risk alleles for all populations (including immigrant populations from outside of the United States).
- Develop large-scale assays to determine the functional consequences of variants of unknown significance (VUS).
- Catalog phenotype and genotype correlations for rare genetic variants based on International Classification of Diseases (ICD) billing codes to bridge the gap between the genome-wide association study (GWAS) Catalog and Online Mendelian Inheritance in Man (OMIM) database.
  - Include variant penetrance, allele frequencies and functional data.
- Develop methods to continuously update family history throughout patient visits and connect clinical decisions with longitudinal familial data.
  - Build patient-facing portals that allow patients to fill out the information themselves.
- Include more detailed codes in EHRs that indicate diagnoses or phenotypes for use in research.

Theme 4: Develop and evaluate genomic prevention and therapeutic strategies
Speakers: Sula Hood, Carol Horowitz, Aniwaa Owusu-Obeng, and Patricia Spears
Moderator: Bob Wildin
Recommendations:
a. Move beyond diagnostics. Identify patients and exemplar diseases that are candidates for genomic therapies and develop these in patient-centered research as model systems for novel, genomically-focused therapeutic strategies.
b. Study utility and implications of RoR on the health of participants, families and communities.
c. Engage communities as partners to determine their goals for genomic medicine.
d. Study dissemination without robust outcome measure to develop data on utility.
e. Develop an effective communication plan to share examples of genomic medicine successes with providers and the public.

In this session, discussants identified several ideas related to the question: How can health improvements from the use of genomics be demonstrated?
- To move beyond diagnostics, NHGRI should engage in the process to identify patients or exemplar diseases that are candidates for genomic therapies and develop these in patient-centered research as model systems for novel, genomically-focused therapeutic strategies.
- Increase diversity in clinical and pharmacogenomic trial participants to ensure accurate patient dosing recommendations. Recruitment could be done through social media, commercials and other platforms.
- Assess gene environment interactions and fund the collection of environmental data, including but not limited to: pollution, rates of poverty, incidents of racism and other structural or institutional prejudice, access to food, healthcare, education, etc.
- Institute a minimum diversity level required for funding to ensure adequate representation of underserved populations including ethnic diversity, geographic location, literacy and education status, and diversity in native language.
- Study utility and implications of RoR on the health of participants, families and communities.
- Innovate strategies to communicate and engage with communities on genomics, including community members as equal partners and stakeholders in research and healthcare.
- Include "human capacity building" as part of a standard grant application to do outreach with communities impacted by the proposed research and communicate results with the public in ways that are accessible to them.
  - Fund to build tools and curriculum and pay community members for their input.

Theme 5: Ensure that genomics has maximum utility for all members of the public
Speakers: Andrew Dwyer, Rachele Hendricks Stirrup, and Jennifer Surtees
Moderator: Colleen Caleshu

Recommendations:
   a. Develop and test implementations of routine genomic medicine in ambulatory and community-based settings.
   b. Study clinical and personal utility from both patient and provider perspectives to determine what they truly value.
   c. Pursue patient and provider perspectives of genomic medicine research studies.
   d. Discuss how family are involved in and affected by genomic medicine, consider privacy and ownership of genomic data.

In this session, discussants identified several ideas related to the question: How do we make sure genomics is available and useful for all?
   • Consider human behavior an integral part of genomic medicine to extend the reach of care and overcome existing barriers to access.
       o Develop a web platform that includes educational modules on genetic testing and its associated risks, how to manage and live with genetic conditions, and communication tools for at-risk patients and their families.
   • Understand how individuals are incentivized and encouraged to engage in genomic information sharing and what are their privacy and other ethical concerns.
   • Develop a curriculum from the elementary to professional (nursing, medical, dental, social workers, public health, etc.) levels to enhance genomic literacy, create online platforms and tools to teach genomics and health, and train laypeople to serve as genomic ambassadors for their communities.
   • Support existing genomic databases, especially ones that face the public such as the Matchmaker Exchange Network.
   • Push for genomics to be routinely included in triage and ambulatory settings, where many people in the U.S. receive care (as opposed to hospitals or institutions affiliated with research programs).
   • Develop best practices for use of genetic data that all researchers should abide by.
   • Study direct-to-consumer testing and return of results outcomes; use these data to develop novel, higher throughput approaches to genetic and genomic services.

Theme 6: Train healthcare providers to integrate genomics into the clinical workflow
Speakers: Dustin Baldridge, Shoumita Dasgupta, Daniel Riconda, and Pam Wilson,
Moderator: Daniel Shriner

Recommendations:
   a. Build just in time Continuing Medical Education (CME) modules that are integrated with clinical decision support tools to manage genomic test results.
   b. Define skills needed for genomic medicine implementation.
   c. Compare and share methods to optimize training for genomic medicine implementation and support.
   d. Engage healthcare professional teams across disciplines and health record systems.

In this session, discussants identified several ideas related to the question: What training is needed to use genomic information for medicine and health?

- Develop a virtual learning platform to serve as a genomics educational gateway.
- Support genomics training for all relevant healthcare delivery teams (not just geneticists and genetic counselors).
- Recruit allied health professions to the practice of genomics by implementing exchange clerkship programs and short courses for those in medical professional schools.
- Engage diagnostic laboratories, assay developers, methods developers and clinicians in diagnosis and train them to integrate high-throughput functional follow-up using machine learning and bioinformatics.
- Develop training materials aimed at specific members of the healthcare team – i.e., nurse practitioners.
- Provide just-in-time education for providers to rapidly make clinical decisions correctly.
- Partner with professional societies to develop a "core genomics curriculum" that every healthcare provider, regardless of sub-specialty, should know.
- Fund "Centers of Excellence" in genomic medicine implementation, training, and outreach who can develop and disseminate best practices in the U.S. and internationally.
- Increase funding for diverse trainees in genomic medicine, counseling and other genetic programs.
- Strengthen investment and expansion of genetic counseling programs to address the shortage of counselors, despite an excess of well-qualified applicants to such programs.
- Increase use of tele-genetic counseling and e-consults in all health systems.

Other ideas:
- Invest in biobanks and repositories to store valuable samples for the future as genomic medicine technologies improve.
- Incorporate sensors and mobile technology (smart watches, etc.) to collect lifestyle and environmental data, as well as quality standards for that data.
- Integrate other -omic technology into the clinic alongside sequencing data.
- Incorporate clinical data into research studies.
- Assess genomic privacy laws (domestic and international) and consider patient perspectives.

In conclusion, workshop participants considered many barriers and opportunities for NHGRI to address at the forefront of genomic medicine. Advancing genomic medicine towards the vision outlined will involve engagement from patients and communities, healthcare teams, researchers, industry (including pharma) and professional societies to ensure that genomic medicine is implemented equally, responsibly, and in a way that propels research and clinical care forward. Participants advocated for prioritizing diversity, community engagement and standardized outcomes/data for all of these themes.

Summary prepared by Alex Raphael and Taylorlyn Stephan