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Regulating Personalized Medicine



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The Obama administration's recently announced ''Precision Medicine Initiative'' will benefit not just from advances in genomics—which allow for an entire human genome to be sequenced in less than a day—but also from significant advances in computing power, the prevalence of electronic health records and even from the 160 million or so smartphones in the hands of U.S. consumers.[1] The plan? To have 1 million volunteers share their genetic data, biological samples and diet and lifestyle information, and to link the data to their electronic health records.[2] That is not as far-fetched a proposition as it might seem.

With the advent of direct-to-consumer genomics companies, individuals increasingly have access to their own genetic data, which has potential usefulness as a genealogical tool, and—in theory—perhaps even as a way to tailor nutrition or skin-care regimes.[3] At least one consumer genomics company has taken a decidedly social approach with an express goal of facilitating consumer-driven disease research; it already has more than 720,000 genotyped customers who have agreed to participate.[4]

The goals of the Precision Medicine Initiative are to:

[1] M. Keshavan, *NIH Workshop Starts Fleshing out Details of Obama's Precision Medicine Initiative*, MEDCITY NEWS (Feb. 19, 2015) http://medcitynews.com/2015/02/nih-workshop-starts-fleshing-details-obamas-precision-medicine-initiative/; T. Burton, J. Rockoff, & R. Winslow, *Obama Announces $215 Million Precision Medicine Genetic Plan*, WALL ST. J. (Jan. 30, 2015) http://www.wsj.com/articles/obama-to-lay-out-215-million-precision-medicine-plan-1422615602.

[2] Keshavan, *supra* note 1.

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[3] *See, e.g.*, F. Lucivero & B. Prainsack, *The Lifestylisation of Healthcare? 'Consumer Genomics' and Mobile Health as Technologies for Healthy Lifestyle*, APPL. TRANSL. GENOMIC. (2015) http://dx.doi.org/10.1016/j.atg.2015.02.001; L. Wade, *Genetic Study Reveals Surprising Ancestry of Many Americans*, SCIENCE (Dec. 18, 2014) http://news.sciencemag.org/biology/2014/12/genetic-study-reveals-surprising-ancestry-many-americans; D. Nielsen & A. El-Sohemy, *Disclosure of Genetic Information and Change in Dietary Intake: A Randomized Controlled Trial*, PLOS ONE (Nov. 14, 2014) http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0112665; S. Wadyka, *Can Your Genes Reveal The Perfect Skin Care For You?* PREVENTION (Jan. 27, 2014) http://www.prevention.com/beauty/skin-care/dna-test-kits-gene-analysis-and-better-skin.

[4] 23andMe, *23andMe Granted Authorization by FDA to Market First Direct-to-Consumer Genetic Test Under Regulatory Pathway for Novel Devices* (Feb. 19, 2015) http://mediacenter.23andme.com/blog/2015/02/19/fdabloomupdate/; Council for Responsible Genetics, *The Future of Consumer Genomics: Sharing is Caring*, http://www.councilforresponsiblegenetics.org/genewatch/GeneWatchPage.aspx?pageId=395 (last accessed April 7, 2015).

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- advance pharmacogenomics, whereby physicians will be able to prescribe ''the right drug for the right patient at the right dose'';
- identify new drug targets for treatment and prevention;
- determine whether mobile devices can be effectively used to encourage healthy behaviors; and
- lay a foundation for the development of new targeted therapies for a variety of diseases.[5]

The vast majority of the initial $215 million in funding is to be used to develop the pool of volunteers, as well as to ''scale up efforts to identify genomic drivers in cancer and apply that knowledge to the development of more effective approaches to cancer treatment.''[6] In theory, the project will one day allow medical treatments to be tailored to a patient's individual ''characteristics, needs and preferences,''[7] and shift the practice of medicine from being reactive to proactive by taking into account the genetic, anatomical and physiological differences among us.[8] It is not by chance that high-tech companies are moving to take advantage of the ''digitized genome.''[9] Nor is it an accident that big pharma has focused more and more on targeted therapies, including those that are only appropriate for patients with certain genotypes.[10]

I. The Evolution of Laboratory-Developed Tests

As the Precision Medicine Initiative unfolds, stakeholders undoubtedly will have to contend with the U.S. Food and Drug Administration's (''FDA'') regulation of key technologies, chiefly, laboratory-developed tests (''LDTs'').[11]

LDTs are diagnostic tests performed entirely in-house: a single lab invents, validates and performs the test, apart from the company that manufactures and markets the corresponding therapy. Although these tests have been quaintly termed ''homebrews,'' they can in fact have a wide reach. While some labs offering LDTs are attached to hospital systems, others are independent companies providing nationwide testing. These tests are still considered LDTs because samples are always shipped to the same lab, and tests are always performed by the same technicians who also designed them in the first place.[12] Some widely used LDTs include Myriad Genetics' breast cancer risk test, Genomic Health's Oncotype DX test and noninvasive prenatal tests for Down syndrome.[13]

Until recently, the FDA did not actively regulate LDTs. Although the agency's view is that LDTs have always been within its jurisdiction, it historically turned a blind eye to them, exercising enforcement discretion.[14] In 1976, when the FDA first started regulating LDTs,[15] genetic tests were much simpler than they tend to be today. They typically were used only locally within the health-care institution directly responsible for the patient, and were run using equipment and materials that had already been FDA-approved for (other) clinical purposes.[16] Thus, LDTs were viewed as posing little risk to patients.[17]

Today, the LDT landscape looks much different. Over a decade after the human genome sequence was declared ''finished,''[18] the cost to sequence any individual genome has dropped from $3 billion to as little as

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[5] NIH, *The Precision Medicine Initiative*, http://www.nih.gov/precisionmedicine/infographic-printable.pdf (last accessed March 23, 2015).

[6] C. Hildebrand, *Three Steps Critical to the Advance of Precision Medicine*, FORBES, (March 23, 2015) http://www.forbes.com/sites/oracle/2015/03/23/three-steps-critical-to-the-advance-of-precision-medicine/.

[7] FDA, *Paving the Way for Personalized Medicine* at 4, (Oct. 2013), http://www.fda.gov/downloads/ScienceResearch/SpecialTopics/PersonalizedMedicine/UCM372421.pdf.

[8] *Id*; Emily Singer, *A Vision for Personalized Medicine*, M.I.T. TECH. REV. (March 9, 2010) http://www.technologyreview.com/news/417929/a-vision-for-personalized-medicine/.

[9] Eric Topol, THE CREATIVE DESTRUCTION OF MEDICINE: HOW THE DIGITAL REVOLUTION WILL CREATE BETTER HEALTHCARE (2012); *see also*, Stacy Lawrence, *What's Next for Next-Gen Sequencing? Everything*, FIERCEMEDICALDEVICES (Jan. 14, 2015) http://www.fiercemedicaldevices.com/story/whats-next-next-gen-sequencing-everything/2015-01-14; Chris Jennewein, *Illumina, Lockheed Martin Team on Personal Genomics*, TIMES OF SAN DIEGO (Jan. 12, 2015) http://timesofsandiego.com/tech/2015/01/12/illumina-lockheed-martin-team-personal-genomics/; Mat Smith, *Google Wants to Define a Healthy Human with its New Baseline Genetic Study*, ENGADGET (Jul. 24, 2014) http://www.engadget.com/2014/07/24/google-genetics-project/.

[10] *See, e.g.*, Steve Dickman, *It Had to be You: Why Roche Was the Lone Suitor for Foundation*, XCONOMY, http://www.xconomy.com/boston/2015/01/16/it-had-to-be-you-why-roche-was-the-lone-suitor-for-foundation/ (Jan. 16, 2015); Novartis, *The Importance of Targeted Therapies*, http://www.novartis.com/innovation/research-development/targeted-therapies/index.shtml (last accessed Jan. 17, 2015); AstraZeneca, *Addressing the Burden of Cancer with Novel Targeted Investigational Therapies* (Sept. 26, 2014) http://www.astrazeneca.com/Media/Press-releases/Article/20140924—addressing-the-burden-of-cancer.

[11] *See, e.g.*, FDA, *Public Workshop - Framework for Regulatory Oversight of Laboratory Developed Tests (LDTs)*, (Jan. 8-9, 2015) http://www.fda.gov/MedicalDevices/NewsEvents/WorkshopsConferences/ucm423537.htm.

[12] Aaron Kroll, *What You Need to Know About the FDA's Push to Regulate Laboratory Developed Tests*, BIO-IT WORLD (Aug. 1, 2014) http://www.bio-itworld.com/BioIT_Article.aspx?id=140557.

[13] Andrew Pollack, *F.D.A. Acts on Lab Tests Developed In-House*, N.Y. TIMES (July 31, 2014) http://www.nytimes.com/2014/08/01/business/fda-to-regulate-lab-developed-test-kits.html?partner=rss&emc=rss&_r=1; Health Net Federal Services, *Laboratory Developed Tests* https://www.hnfs.com/content/hnfs/home/tn/prov/benefits/benefits_a_to_z/laboratory_developed_tests/laboratory_developed_tests_details.html (last accessed March 25, 2015); Christopher Weaver, *Tough Calls on Prenatal Tests*, WALL ST. J. (April 3, 2013) http://www.wsj.com/articles/SB10001424127887324883604578398791568615644.

[14] Kroll, *supra* note 12.

[15] Medical Device Amendments of 1976, Pub. L. No. 94-295, 90 Stat. 539 (codified as amended in scattered sections of 21 U.S.C.); *see also*, FDA, *What is a Medical Device?* http://www.fda.gov/aboutfda/transparency/basics/ucm211822.htm (last accessed March 23, 2015) (defining ''medical devices'' to include reagents intended for use in diagnosing or treating a disease).

[16] FDA, Draft Guidance regarding Framework for Regulatory Oversight of Laboratory Developed Tests (LDTs) (issued Oct. 3, 2014) [hereinafter, FDA Framework Document].

[17] Kroll, *supra* note 12.

[18] National Human Genome Research Institute, *The Human Genome Project Completion: Frequently Asked Questions*, http://www.genome.gov/11006943 (last accessed Jan. 17, 2015).

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$1,000.[19] With the advent of widespread use of next-generation sequencing (''NGS'') technology, some estimates indicate that 1.6 million human genomes will be sequenced by 2017.[20]

As the era of personalized medicine unfolds, physicians are better able to tailor treatment to their patients' genetics. There are over 15,000 tests for 2,800 genes; albeit only a fraction of them currently can be used to inform a choice of a particular therapy.[21] As of 2014, there were a little over 100 drugs that were marketed with pharmacogenomic information on their labels.[22] Most of these drugs were cancer therapies with a companion diagnostic; these therapies are only useful for patients who carry particular gene mutations.[23] Genomics also has provided a window into the variations in the effectiveness of drugs that are used to treat asthma, diabetes, arthritis, Alzheimer's and depression.[24] In theory, better information about a patient's genetics could lead to better outcomes.

II. FDA Regulation

Access to a wealth of genetic information, however, does not come without risks:

> The FDA has identified problems with several high-risk LDTs . . . [and] is aware of faulty LDTs that could have led to: patients being over- or undertreated for heart disease; cancer patients being exposed to inappropriate therapies or not getting effective therapies; incorrect diagnosis of autism; unnecessary antibiotic treatments; and exposure to unnecessary, harmful treatments for certain diseases such as Lyme disease.[25]

LDTs have already been regulated under the Clinical Laboratory Improvement Amendments (''CLIA''). The Centers for Medicare and Medicaid Services must inspect labs that perform clinical tests to ensure that technicians are trained and that equipment is functional and accurate.[26] But CLIA regulations do not ensure that an LDT is safe and effective prior to commercial launch.[27] They do not mandate adverse event reporting. They do not require an assessment of how well an assay is designed, or a consideration of how it is manufactured. And they do not require informed consent from patients apart from the consent that is provided regarding the corresponding therapy.[28]

The FDA's draft guidance issued last October indicates that the agency intends to apply varying degrees of scrutiny to LDTs, depending on the risk,[29] consistent with its approach to regulating medical devices generally. Under the guidance, an LDT is ''an IVD [*in vitro* diagnostic] that is intended for clinical use within a single laboratory.''[30] Admittedly, some of these tests are simple, such as those that measure single analytes like sodium. Others, however, are far more complex, such as those that detect variations in nucleic acid that is isolated from patient blood samples. The proposed guidance will potentially affect more than 2,000 labs, and over 11,000 tests.[31]

Similar to other medical devices, LDTs will fall into one of three categories: Class I includes devices posing the smallest risk, Class II includes those posing an intermediate risk, and Class III includes those posing the greatest safety risk to patients. The classification level of the device indicates the level of oversight the FDA deems necessary to ''provide a reasonable assurance of the safety and effectiveness of the device.''[32] Class I LDTs are subject only to the general controls that apply to all medical devices. Class III LDTs, as the riskiest devices, are subject to greater controls, including premarket approval.[33] In determining the level of risk of an LDT, the FDA will consider several factors including:

- whether the device is intended for use in high-risk disease/conditions or patient populations,
- whether the device is used for screening or diagnosis,
- the nature of the clinical decision that will be made based on the test result,
- whether a physician/pathologist would have other information about the patient to assist in making a clinical decision (in addition to the LDT result),
- alternative diagnostic and treatment options available to the patient,
- the potential consequences/impact of erroneous results, and
- number and type of adverse events associated with the devices, etc.[34]

Following finalization of the draft guidance, the FDA intends to release further guidance regarding LDT classification.[35] It also has identified some of the LDTs with which it is most concerned, and on which it will focus its initial enforcement efforts, including LDTs that function as companion diagnostics, LDTs for screening for serious diseases or conditions when there are no other available diagnostic products or procedures and LDTs for certain infectious diseases with high-risk intended

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[19] Antonio Regalado, *EmTech: Illumina Says 228,000 Human Genomes Will Be Sequenced This Year*, MIT TECH. REV. (Sept. 24, 2014) http://www.technologyreview.com/news/531091/emtech-illumina-says-228000-human-genomes-will-be-sequenced-this-year/.

[20] *Id*.

[21] PMC, *The Case for Personalized Medicine*, at 8 (4th ed. 2014) http://www.personalizedmedicinecoalition.org/Userfiles/PMC-Corporate/file/pmc_the_case_for_personalized_medicine.pdf.

[22] *Id.* at 5, Fig. 1.

[23] FDA, *Personalized Medicine and Companion Diagnostics Go Hand-in-Hand*, http://www.fda.gov/ForConsumers/ConsumerUpdates/ucm407328.htm (last accessed Jan. 17, 2015); PMC, *supra* note 21, at 9-11.

[24] PMC, *supra* note 21, at 11.

[25] FDA, *Laboratory Developed Tests*, http://www.fda.gov/MedicalDevices/ProductsandMedicalProcedures/InVitroDiagnostics/ucm407296.htm (last accessed April 20, 2015).

[26] Kroll, *supra* note 12.

[27] FDA Framework Document at 8–9.

[28] *Id*.

[29] *See generally*, *id*.

[30] *Id.* at 5.

[31] Matthew Herper, *FDA to Regulate Thousands of Cancer, Genetic, and Other Diagnostics*, FORBES (July 31, 2014, 1:03 PM) http://www.forbes.com/sites/matthewherper/2014/07/31/fda-to-regulate-thousands-of-cancer-genetic-and-other-diagnostics/.

[32] FDA Framework Document at 11.

[33] *Id*.

[34] *Id.* at 11–12.

[35] *Id.* at 12.

uses (i.e. where a false negative would put a patient at a high risk of death from infection).[36]

In implementing its regulatory framework, the FDA intends to continue to exercise full enforcement discretion for some assays. LDTs used solely for forensic, law enforcement purposes will not be subject to any FDA controls. Also, the agency will not regulate certain LDTs used in connection with organ, stem cell and tissue transplantation. In conceding this category of LDTs, the agency recognized that these technologies are ''rapidly evolving'' and that ''enforcement of FDA regulatory requirements . . . could lead to the unavailability of testing.''[37]

In addition to these categories of full enforcement discretion, the FDA will use enforcement discretion in premarket review requirements for low-risk LDTs, ''[t]raditional LDTs,'' LDTs used for rare diseases and LDTs for unmet needs.[38] These LDTs, however, will be subject to registration and listing and reporting requirements. Here, enforcement discretion is meant to incentivize development of testing and treatment in these underserved areas.[39]

For those LDTs that do not fall into one of the enforcement discretion categories, the FDA will regulate according to classification. Class I LDTs will be subject to general controls: manufacturer reporting requirements and registration and listing requirements.[40] Class II and Class III LDTs will additionally be subject to premarket review and quality system regulation requirements.[41]

LDTs have been and will continue to be developed using NGS platforms. To date, FDA-approved NGS-based assays have an advantage over more traditional LDTs because they allow for a broader query. For example, one of the approved, NGS-based cystic fibrosis assays allows for the detection of 139 different genetic variants that are associated with the disease as opposed to testing only for the variants most commonly found in Caucasians.[42] And the other approved assay has the advantage of querying the entire protein coding sequence of the CFTR gene (the cystic fibrosis transmembrane conductance regulator), as well as intron/exon boundaries and known deletions and intronic mutations.[43] The FDA also has approved a particular NGS platform and reagents.[44]

Last fall, at an NGS Diagnostic Summit, agency representatives:

> stressed . . . that the agency is eager to work with companies to expand access to NGS testing in the clinic. While there are significant challenges to validating these tests to the FDA's standards — in particular, they can cover such a wide range of genetic variants that it is effectively impossible to verify that each one is called and interpreted correctly — a combination of careful labeling, and creative references, can overcome these obstacles. The intended use, and the indications for use, are the key to . . . [the] review . . . so being specific about what a test can and cannot capture, and how this should impact clinical practice, can go a long way toward satisfying the FDA.[45]

In February, the FDA conducted a public workshop aimed at optimizing its regulatory oversight of NGS diagnostic tests. The FDA emphasized its commitment to ''[a]ppropriately-tailored oversight'' that would ''foster innovation in NGS technology, allow the public to have timely access to newly developed tests, and ensure that those tests are accurate, reliable and clinically relevant.''[46] The FDA noted that after hearing from stakeholders, it would ''determine the types of changes, if any, that it should initiate with respect to its oversight of NGS tests.''[47] The agency has not provided any official updates since the workshop, so it remains to be seen whether the FDA will make changes to its NGS guidance.

III. Reactions From the Industry

Not all stakeholders view FDA regulation of LDTs as favorable. A white paper released by the Association for Molecular Pathology (''AMP'') expresses the view that ''the breakthroughs made possible by mapping the human genome are being endangered by government regulations which are threatening patient access to these truly revolutionary treatments.''[48]

With respect to LDTs, the AMP explains that appropriately qualified professionals are already involved in every aspect of LDTs. CLIA regulations require that laboratory directors and technical supervisors select test methodologies that are capable of providing the quality of data required for patient care, which implicitly requires that an effective clinical purpose or clinical validity be documented in the medical literature.[49] FDA regulations would restrict off-label promotion of LDTs, which would hinder the ability of a patient's physicians determining that an off-label use is appropriate after clinical consultation with molecular pathologists and other professionals as appropriate.[50] The proposed regulations concern the AMP because they would interfere with the ability to modify any existing test using ''the best and most relevant scientifically-verified information available,'' and create barriers to adapting and

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[36] *Id.* at 26–27, 27 n.37.
[37] *Id.* at 12, 16.
[38] *Id.* at 15.
[39] *See id.* at 20.
[40] *Id.* at 30.
[41] *Id.*
[42] Illumina, *MiSeqDx Cystic Fibrosis 139-Variant Assay*, http://res.illumina.com/documents/clinical/datasheet_miseqdx_cfcarrierscreenassay.pdf (last accessed Jan. 19, 2015).
[43] Illumina, *MiSeqDx Cystic Fibrosis Clinical Sequencing Assay*, http://www.illumina.com/products/miseqdx-cystic-fibrosis-diagnostic-assay.html (last accessed Jan. 19, 2015).
[44] FDA, *FDA Allows Marketing of Four ''Next Generation'' Gene Sequencing Devices,* (Nov. 19, 2013) http://www.fda.gov/NewsEvents/Newsroom/PressAnnouncements/ucm375742.htm.
[45] Clinical Informatics News, *At Next Generation Dx Summit, FDA Discusses Approval of NGS Assays,* (Aug. 22, 2014) http://www.clinicalinformaticsnews.com/2014/8/22/next-generation-dx-summit-fda-discusses-approval-ngs-assays.html.
[46] FDA Public Workshop, *Optimizing FDA's Regulatory Oversight of Next Generation Sequencing Diagnostic Tests—Preliminary Discussion Paper*, http://www.fda.gov/downloads/MedicalDevices/NewsEvents/WorkshopsConferences/UCM427869.pdf (Feb. 20, 2015).
[47] *Id.*
[48] Association for Molecular Pathology, Victoria M. Pratt et al., *A Molecular Diagnostic Perfect Storm: The Convergence of Regulatory & Reimbursement Forces that Threaten Patient Access to Innovation in Genomic Medicine,* at 2, (Jan. 8, 2015) http://www.amp.org/publications_resources/position_statements_letters/PerfectStorm.cfm.
[49] *Id.* at 5.
[50] *Id.* at 5-6.

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improving LDTs to account for risks that are not clearly documented.[51]

The AMP also has expressed a concern regarding the FDA's approach to companion diagnostics, because it has focused on a particular assay, instead of the relevant biomarker. The agency's final guidance on companion diagnostics overlooks the fact that there are existing examples of biomarker tests that are applied in connection with the delivery of a therapy, even though there was no pre-market review by the FDA of the diagnostic. Moreover, the current approach might put smaller laboratories at a significant disadvantage because most companion diagnostics are approved to be run as a single assay. That is, they are not approved to be run on a shared instrument, and it is generally more efficient to implement a platform that can be used for multiple different assays at one time.[52]

The AMP also holds the view that the FDA's guidelines will interfere with modifications to testing procedures that are allowed under CLIA guidelines. For example, under CLIA guidelines, modifications like changes to the type of sample being tested (e.g. chorionic villi samples versus whole blood samples) need only be validated.[53] By contrast, under the FDA's draft guidance, similar changes would have to be submitted to the agency for premarket approval.[54]

The AMP has made recommendations that include the following:

- Oversight for most LDTs should continue under CLIA regulations, which should be modernized.
- The FDA should eliminate its ''one test-one drug'' companion diagnostic paradigm in favor of facilitating the use of additional diagnostics, including multi-gene sequencing assays.[55]
- The FDA should use notice-and-comment rulemaking for any substantive policy changes, and should withdraw draft guidance documents that are not finalized within a defined amount of time.
- Regulator and payer policies should reflect the contribution of molecular diagnostics to medical training, and the necessary interaction between clinicians and laboratories to support the proper utilization of LDTs.[56]

Similarly, the American Clinical Laboratory Association (''ACLA'') also has taken a stance against the FDA's proposed guidance on LDTs.

The ACLA characterizes LDTs—proprietary methods that are only performed by the laboratory that developed them—as distinct from medical devices or drugs, which are sold and accompanied by instructions for use. The end result of an LDT is not a ''product'' but data, which can be used by a physician to assist in her treatment of patients.[57] Where the economies of scale do not justify a stand-alone, commercially marketed product, an LDT is often the only option for testing for a rare disease or condition.[58] Moreover, absent FDA oversight, laboratories are free to ''continually modify and validate their tests to ensure that they reflect the most up-to-date technological know-how, scientific breakthroughs, and published research that will enable doctors to better serve their patients.''[59]

The ACLA's view is that Congress has already expressly addressed regulation of LDTs via CLIA, not through the FDA's authorizing statute, the Federal Food, Drug and Cosmetic Act (''FDCA'').[60] Furthermore, according to the ACLA, LDTs are not ''devices,'' subject to FDA regulation. Both in common English usage and consistent with the plain text of the FDCA, a ''device'' is a physical article than can be put into interstate commerce.[61] The agency is not authorized to regulate the practice of medicine, which includes a physician ordering an LDT, a medical service.[62]

The ACLA also has argued that even if LDTs were within the FDA's authority, its proposed guidance is actually a set of ''binding, substantive obligations,'' which should be set aside in favor of ''notice-and-comment'' rulemaking.[63] Unlike the current proposed guidance, a notice-and-comment approach would require that the agency consider and meaningfully respond to relevant and significant comments.[64] By contrast, the proposed guidance would require significant, specific undertakings by all laboratories that carry out LDTs.[65]

In January, the FDA held a public, two-day workshop, inviting stakeholders to present their viewpoints in an open forum. Many presenters expressed similar concerns. For example, there was a lot of concern surrounding the sheer number of tests that the FDA will be committing itself to regulate, and whether the FDA actually has enough infrastructure to implement the guidance. Another big concern was the long turnaround time for FDA approvals and FDA's inability to keep pace with important medical advances. Many stakeholders expressed the view that the current regulatory framework is sufficient to ensure patient safety, and that the FDA's approval process would take a significant amount of time, thereby delaying implementation of new tests, stifling innovation, increasing development and compliance costs and limiting patient access to tests.[66]

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[51] *Id*. at 6.
[52] *Id*. at 6-7.
[53] *Id*. at 7.
[54] *Id*. at 8.
[55] *See also*, Joseph Khoury and Daniel Catenacci, *Editorial: Next-Generation Companion Diagnostics—Promises, Challenges, Solutions*, 139 Arch. Pathol. Lab. Med. at 11-13 (January 2015).
[56] Association for Molecular Pathology, *supra* note 48, at 3-4 (proposing 10 recommendations).
[57] Paul D. Clement and Laurence H. Tribe, *Laboratory Testing Services, As the Practice of Medicine, Cannot Be Regulated as Medical Devices*, (Jan. 7, 2015) http://www.acla.com/wp-content/uploads/2015/01/Tribe-Clement-White-Paper-1-6-15.pdf.
[58] *Id*. at 5.
[59] *Id*. at 5-6.
[60] *Id*. at 7.
[61] *Id*. at 8-10; *see also,* 13-16.
[62] *Id*. at 11-12; *see also,* 16-19.
[63] *Id*. at 19.
[64] *Id*. at 23.
[65] *Id*. at 21.
[66] *See generally*, FDA, *Public Workshop - Framework for Regulatory Oversight of Laboratory Developed Tests (LDTs)*, Transcript, (Jan. 8–9, 2015) http://www.fda.gov/MedicalDevices/NewsEvents/WorkshopsConferences/ucm423537.htm#transcripts.

IV. The Future of Regulating Personalized Medicine

Following the public workshop and a 120-day public comment period that ended in February, it remains to be seen how the FDA will incorporate the feedback it has received on LTDs. Nevertheless, the FDA must balance the interests of patients and health-care providers to have access to possibly revolutionary technology that may assist in the diagnosis and treatment of various illnesses with the ever present concern of allowing such revolutionary technology early entry into the health-care regime before sufficient controls and a track record of public safety have been established. In particular, what are the consequences of having too much information, not only for a particular patient but for a population?

DeCode Genetics, for example, has the complete DNA sequences of 10,000 Icelanders. But, because the country's population is closely related, it can predict the genetics of ''nearly all'' of the country's 320,000 citizens, including those who never agreed to participate in any study.[67] Bioethicists and the country's Ministry of Welfare are now faced with the conundrum of what to do with the large volume of incidental findings, which must be balanced against the wishes of individuals in the study who were guaranteed anonymity, as well as the right of non-participants ''not to know'' of genetic risks.[68]

In today's age of being able to obtain and process unbelievable quantities of genetic data in relatively short periods of time, a significant benefit could be realized by these technologies. The key will be balancing what is technologically possible with patient privacy and with patient care that is safe, effective and affordable.

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[67] Antonio Regalado, *Genome Study Predicts DNA of the Whole of Iceland*, M.I.T. TECH. REV. (March 25, 2015) http://www.technologyreview.com/news/536096/genome-study-predicts-dna-of-the-whole-of-iceland/.

[68] *Id*.

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