

# Benefits and Risks of Direct-to-Consumer Testing

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• **Context.**—Convenience, avoidance of doctor's appointments, curiosity, and the desire to take control of one's health are driving interest toward direct-to-consumer (DTC) testing. DTC is laboratory testing that is initiated by the consumer without a physician order. The results are reported back directly to the consumer. DTC testing is an exciting addition to the traditional healthcare model for consumers who want knowledge of their health status and disease risk, ancestry, and their body's expected response to certain medications based on their genotype.

**Objectives.**—To discuss the perceived and potential benefits and risks involved in DTC testing.

The traditional model of laboratory testing in healthcare starts with the patient recognizing the need to see a physician (Figure 1). In nonemergent cases, the patient must make an appointment with their primary care provider (PCP) and wait for the date of their appointment. A 2017 survey of physician appointment wait times found delays up to 24 days for a patient to see their PCP.<sup>1</sup> A patient will travel to their appointment and wait again before, during, and after their appointment is completed. The clinician will discuss the plan of care with the patient, which may include sending the patient for laboratory testing. Waiting for test results and interpretative information from their doctor can be a source of anxiety. Understandably, consumers are ready for a new healthcare model.

The advent of direct-to-consumer (DTC) testing changed access to laboratory testing. Depending on regional laws, individuals may order testing directly without undergoing an examination by their PCP. Other names for DTC testing are "direct-access testing," "patient authorized testing," and "consumer-initiated testing." A recent explosion of interest in tracking and monitoring health has fueled the market for DTC testing as well as for health tracker devices and phone applications. Consumers find it empowering to choose what tests will be performed and to have access to results so they can decide what personal significance those results have for

**Data Sources.**—Recent published literature on DTC testing.

**Conclusions.**—The benefits of DTC testing are enticing and are driving the DTC testing market. Consumers must weigh the perceived benefits with the potential risks, including privacy concerns, the possibility of receiving confusing health information, and/or information that could generate unexpected emotions, misdiagnosis, and over-testing.

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them. DTC testing is disruptive to the current traditional healthcare model and it is a movement that cannot be reversed. In this review, we will discuss perceived benefits and risks of DTC testing.

## MODERN MODEL OF LABORATORY TESTING IN HEALTHCARE WITH DTC TESTING

In an era of DTC testing, the traditional healthcare model functions typically the same. However, in the modern model, individuals circumvent their physician and order testing themselves at any point in the process (Figure 2). The individual can browse online to find the tests they desire and request a collection kit from their own home. The sample is collected with a home device and mailed to the laboratory according to instructions. If blood analysis is required, a capillary blood collection kit may be used, or the consumer can schedule an appointment or directly visit a collection center that offers walk-in blood collection. Blood spot testing may also be available where a fingerstick blood collection is blotted onto filter paper, air dried, and then mailed to the laboratory. The consumer is notified once the test results are ready. The patient can then choose whether to follow-up with their healthcare provider and share the results with them. In that case, they will enter the traditional healthcare model, by initiating an appointment with their PCP. DTC companies may provide their customers with information on how to contact genetic counselors and physicians through telehealth who can advise the consumer about their results, help with result interpretation, and answer questions.

## USES FOR DTC TESTING

The DTC test menu is ever expanding, and DTC tests are marketed for a variety of uses. Common sample types are cheek swabs, saliva or spit, urine, hair, blood spots, or blood (Figure 3). A variety of DTC tests are available, for example, complete blood counts, chemistries, enzymes, thyroid and hormone analysis, lipid panels, diabetes, cancer screening

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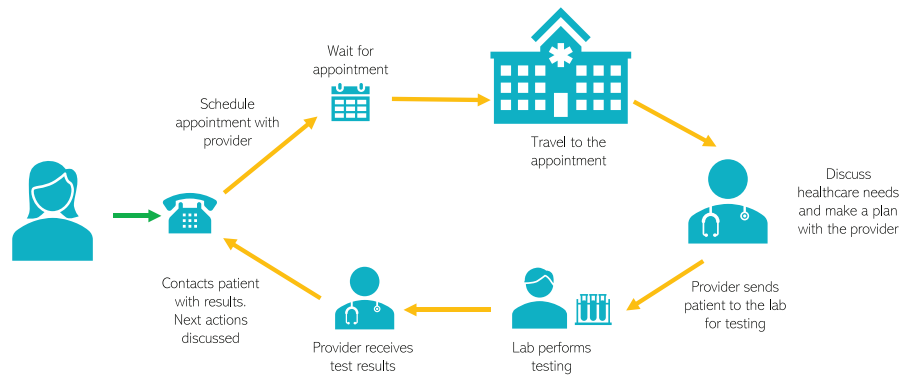
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**Figure 1.** Traditional model of laboratory testing in healthcare.



(prostate-specific antigen), heavy metals (lead, arsenic), toxicology (drugs of abuse, designer drugs), steroids and sports doping, therapeutic drug monitoring (lithium, phenytoin), celiac (inflammatory bowel syndrome, Crohn’s disease), women’s health (fertility, pregnancy, menopause), rape and unknown ingestions, and sexually transmitted diseases (HIV, herpes simplex virus I and II, chlamydia, syphilis, gonorrhea). There are thousands of DTC tests currently available with more being developed. One common test is DTC genetic tests, which uses a saliva sample and is analyzed by genotyping. DTC genetic test companies offer ancestry testing and other health-related tests, which provide information on genetic health risk and pharmacogenetics. Test kits can have a cost starting from US \$99. DTC genetic test companies provide customers with information updates as more evidence is gained about the meaning of their DNA results in the future. This may be attractive to consumers wanting to stay abreast of scientific updates regarding their health and predisposition for disease. Nonhealth drivers of DTC testing include discovering one’s ancestry, completing family trees, and connecting with living family members. DTC tests are also being marketed to provide information for nutritional optimization, allergy testing, family planning, and paternity testing.

lifestyle. In-office wait times can be lengthy and are negatively correlated with patient satisfaction and likelihood to recommend a physician.<sup>2</sup> On the other hand, DTC companies provide testing without an appointment. Many companies also offer telehealth options for consumers to discuss laboratory results with a medical professional. Although additional fees for consultation services may apply, the cost may be less than the cost of an exam with their PCP and the additional costs of any necessary laboratory testing. DTC testing is not covered by health insurance at this time. Individuals with insurance may opt for DTC testing when the costs of paying out-of-pocket for DTC are lower than the copays for a PCP visit plus the required laboratory charges ordered by their provider. Depending on the type of test and geographic area, consumers may be able to shop for different DTC companies offering testing at the lowest cost, whereas insurance companies dictate the laboratories that patients must use.

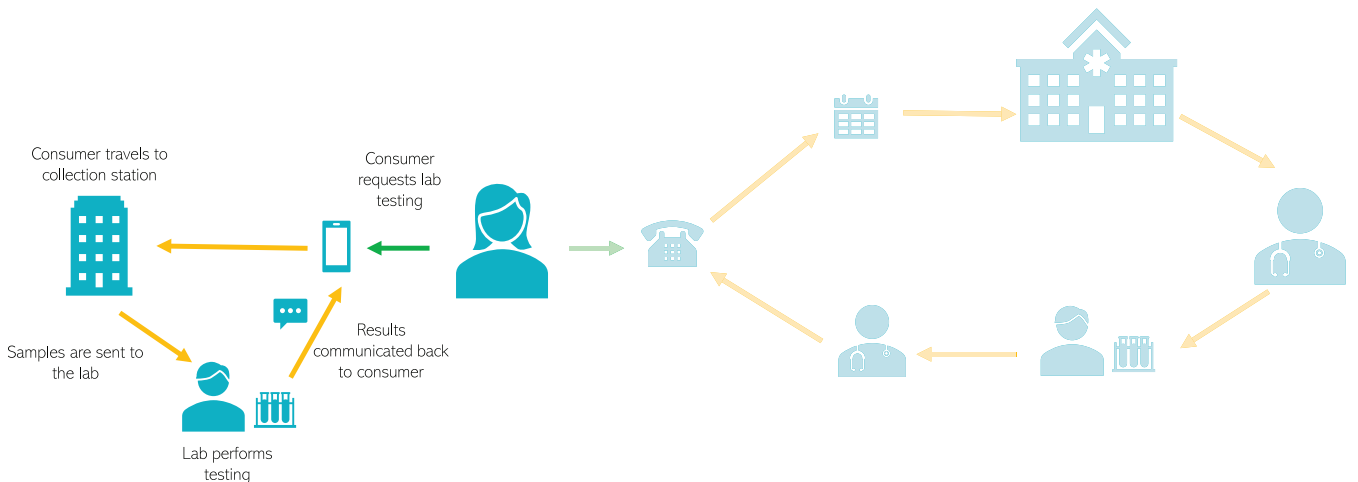
### Avoiding Being a “Patient”

Obtaining tests and results about one’s health outside of a healthcare system removes common barriers to laboratory testing, such as iatrophobia, or the fear of doctors and medical institutions. Iatrophobia includes a patient’s fear of physician reaction, fear of illness and the medical exam, and fear related to barriers to care, such as health insurance and financial status.<sup>3</sup> Doctor’s office visits are well-documented to produce “white coat syndrome,” which is an elevation in blood pressure that only occurs in the medical setting. Furthermore, 20% to 30% of young adults have a fear of

## POTENTIAL AND PERCEIVED BENEFITS OF DTC TESTING

### Cost and Convenience

The inconvenience of scheduling and waiting for an appointment with a PCP interferes with an individual’s



**Figure 2.** Model of laboratory testing in healthcare with direct-to-consumer (DTC) testing.

needles.<sup>4</sup> Many DTC tests can be analyzed using minimally invasive samples, such as urine, saliva, hair, or blood spots (drop of capillary fingerstick blood applied to filter paper). Collecting samples at home can avoid the anxiety of visiting a doctor's office and the associated exam procedures, while still being active in health maintenance.

### Confidentiality

Another attraction of DTC is confidentiality. Results are not reported to the consumer's insurance company or their medical provider unless the patient shares the result themselves. Individuals may feel more comfortable seeking out testing options for sexually transmitted infections, screening for drugs of abuse, reproduction, and fertility-related tests when the results will be confidential.

### Empowerment Through Information to Control One's Health

In a study of individuals offered DTC, motivations included general curiosity for the process and the information they may discover, to gain actionable knowledge, and to be altruistic.<sup>5</sup> Individuals want the ability to know their risk for disease and to detect disease early, to allow lifestyle changes and make healthcare decisions, including whether to follow up with their provider. DTC companies, however, may overstate the ability of results to provide the right lifestyle changes based on an individual's genetic makeup. Women in a research study who completed DTC ovarian reserve testing reported feeling more empowered and in control of their reproductive future.<sup>6</sup> Altruistic reasons that drive consumers to participate in DTC testing include providing data to advance medical knowledge. In addition, individuals may see participation in DTC testing as useful to family planning and to provide information to their relatives with predisposition for disorders, like sickle cell disease.<sup>5</sup>

### Consumer Experience

Competition for the consumer market has fueled innovation, and the development of attractive advertising with sophisticated content strategies. DTC testing provides results with the consumer in mind, while clinical laboratories provide results to a clinician who will interpret and discuss results with the patient. In the medical laboratory setting, marketing is aimed at clinicians and laboratory administrators. Patients do not typically choose their medical providers based on the laboratory they are associated with or the quality of laboratory testing. This is in stark difference to DTC testing, which develops a brand loyalty for a specific company to support their line of products and services. Just like consumers at a retail shop can research the products and buy the items off the shelves, individuals are attracted by the ease of DTC testing to select and purchase laboratory tests. Other perceived benefits are outlined in Table 1.

### RISKS

#### Privacy

Companies, with consent, may use data for other purposes besides reporting test results to the consumer. DTC companies have provided de-identified data in aggregate to third parties, as occurred when Glaxo-SmithKline made a \$300 million investment in 23andMe as part of a collaboration to enable drug discovery research. Expectations of external financial support has maintained a

**Table 1. Potential and Perceived Benefits of Direct-to-Consumer Testing**

Convenience	Faster (no waiting for appointments) Avoid the doctor/hospital Results delivered by email or phone app Telemedicine options
Cost	Avoid paying for a doctor's appointment Consumer able to shop for lowest cost test
Confidentiality	Tests ordered by consumer Results not reported to employer or insurer
Experience	User friendly reports Personalized delivery of information
Innovation/Technology	Faster innovation of commercialized tests Re-query data as new evidence published
Autonomy	Patient has more control over the process Empowered with information "Right to know" about oneself
Prevention	Preventative measures can be taken Motivate positive lifestyle changes
Early Intervention	If risk detected, can alter lifestyle Follow-up with healthcare provider
Family Planning	Disease carrier risk
Nonhealth	Discover family members Fill in ancestry trees "Infotainment"
Emotional	Relief (if results negative—no disease) Avoid anxiety of doctor/hospital
Community	Social media tools to connect with company Connect with others in similar situation Make new friends, share health experiences
Educational	Gain appreciation for biomedical science Learning experience Self-discovery, learn about yourself
Altruistic	Gain information that can help family/others Participate in research Add data for underrepresented populations

structure for business models that offer a low cost to consumers offset by the selling of the aggregate data to researchers, insurers, and pharmaceutical companies.<sup>7</sup> The management and transfer of health information is highly regulated in healthcare. The Health Insurance Portability

and Accountability Act privacy laws apply to healthcare providers, health plans, and healthcare clearinghouses. However, DTC companies are not covered under the Health Insurance Portability and Accountability Act, and oversight and policies to protect consumer test results are lacking. In the United States, the Genetic Information Nondiscrimination Act of 2008 prohibits discrimination based on results from genetic testing for employment and basic health insurance. Protections under the Genetic Information Nondiscrimination Act do not extend to employers with fewer than 15 employees, nor does it protect against discrimination for life, disability, or long-term care insurance, or use by law enforcement.<sup>8</sup> The Fourth Amendment of the United States Constitution protects citizens from unreasonable search and seizure. Whether this protection applies to law enforcement use of publicly available data is under scrutiny. Law enforcement agencies have public DNA databases to conduct searches that match genetic profiles obtained from crime scene evidence.<sup>9</sup> Identification of individuals using genetic information and publicly available information (voting records, phone directories) is possible based on their de-identified genetic profile.<sup>10</sup> It is also possible to discover the genotypes of individuals who have uploaded their data into genetic databases through methods, such as identical by state baiting, where multiple datasets are uploaded as “bait” to discover matches.<sup>11</sup> A further concern is once a consumer learns of a particular health risk from a DTC test and follows up with a medical provider, the information shared becomes part of their medical record.

### Cost

Testing initiated by the patient is not covered by most insurance plans. While most DTC tests (lipid panels, chemistries, hormones, and drug screens) are reasonably priced, DTC genetic testing can be prohibitively expensive to the patient without the assistance of insurance and may not be worth the cost when considering the limited amount of actionable knowledge gained from such testing. Furthermore, patient-initiated testing may lead to unnecessary follow-up investigations from false-positive results (e.g., cholesterol for cardiac risk or hemoglobin A1c for diabetes), which may or may not be covered by insurance. Information gained by the consumer may affect the ability to obtain insurance coverage in the future (e.g., diabetes, HIV, or other chronic disease diagnosis).

### Analytical/Technical Concerns

As with clinical laboratories, tests conducted by DTC companies should consider analytical and clinical performance of the test, including accuracy, precision, sensitivity, and specificity of the tests. All tests conducted for patient care in the United States are regulated by the Clinical Laboratory Improvement Amendments of 1988 (CLIA). CLIA sets minimum quality for laboratory testing used for medical decisions, but excludes tests for research, forensics, and veterinary purposes. CLIA divides tests into waived, moderate, and high complexity with increasing requirements for the validation and documentation standards of higher complexity tests. Depending on the testing methodology, laboratories may offer simple CLIA waived tests like hemoglobin A1c or urine pregnancy to higher complexity mass spectrometry, molecular, and genetics testing. CLIA is a federal law that sets regulations for test performance based on test complexity, but state laws, with some states limiting

the menu that consumers can order without a physician interaction. Because DTC samples are shipped to laboratories with appropriate CLIA certification, the results can be used for patient care. However, DTC companies may offer CLIA-approved tests for medical purposes as well as testing for entertainment, such as tendency for premature hair loss, morning aptitude, sweet or dry wine preference, and loneliness. This can be confusing to consumers who may not be aware of the distinction or know which tests are medically valid and which are not. Technical limitations and lack of standardization of assays complicate the use of DTC test results. Assays may not yield the same results on different platforms or when offered by different companies, which complicates using DTC tests to monitor health trends over time.

### Testing Without Regard to Clinical History or Adherence to Testing Guidelines

DTC companies can overstate the value of their tests to make healthcare decisions. In a study where participants obtained DTC, a year later only half of the participants had made any lifestyle changes in response to their results.<sup>5</sup> With many DTC assays, it is unclear how tests perform in the general population compared with studies conducted in controlled populations with higher disease prevalence. The prevalence of some conditions in the general population is not known and cutoffs for results based on high-risk select populations may not be applicable to the larger general population with low risk of the disease. Clinicians consider pretest probability when ordering tests and interpreting test results for individual patients. Also, some ethnic populations are not well represented in normal reference intervals.

The relative risk of a disease for a specific patient determines which tests to order and whether to order certain tests at all. A physician considers the patient’s family, medical history, symptoms, and future goals (such as treatment preferences) when advising patients to undergo testing. Selecting and interpreting test results without consideration of pretest probability and medical history risks clinical misinterpretation. One example of the confusion that can arise when interpreting DTC test results is the woman who wants to know if she is undergoing menopause. Menopause tests may only offer follicle stimulating hormone, but follicle stimulating hormone is poorly correlated with menopause symptoms. Stress, not eating regularly, and drinking alcohol can cause missed periods and elevate follicle stimulating hormone. So, endocrinologists will typically analyze not just follicle stimulating hormone but also progesterone and estrogen levels. This allows a better picture of the patient’s hormones in order to determine menopausal status. Another example of possible consumer misinterpretation is sperm counts for fertility. Some methods detect only a sperm protein or use a colored label to quantitate the amount of DNA in the sample rather than actually counting the number of sperm microscopically. These colorimetric tests trigger a positive result around 20 million sperm/mL; however, fertility is also related to sperm motility, vitality (the number of alive sperm), and morphology. So, consumer interpretation of test results is more challenging than just reviewing a test result. Consumers, unlike medical professionals, will not necessarily appreciate how clinical history, symptoms, medications, and test methodology and analytic performance relate to test interpretation. For DTC genetic testing, because of the complexities of genetic information and the formidable

challenges in making appropriate interpretations, the American College of Medical Genetics and Genomics recommends that only qualified genetics experts should be involved in the ordering and interpretation of genetic tests.<sup>12</sup> The existence of DTC testing has created another layer to the provider–patient relationship. A patient empowered by the DTC testing experience may be motivated to collaborate with their physician based on an abnormal test result and develop a healthcare plan in line with their values, preferences, and personal risk for disease. However, a patient may also be at odds with their provider because of a misinterpreted normal DTC result, their limited medical knowledge, and falsely believe they do not have a suspected condition or need to seek treatment.

### Self-Misdiagnosis

Tests may yield an incorrect result, which can lead to an incorrect diagnosis. A recent study of 49 patients with DTC testing that was confirmed in a laboratory setting revealed a 40% false-positive rate.<sup>13</sup> Consequences of false positives can include unnecessary lifestyle changes and unwarranted surgeries, therapies, medications, and procedures. DTC companies encourage customers to consult with medical professionals before and after testing; however, this is often not a required step. Consumers make the decision for DTC testing on their own and interpret the results on their own. One specific challenge with interpretation of genetic results compared with other DTC tests is that genetic test results are often reported as health risk percentages, which associates a particular variant with a disease. A high genetic risk does not indicate the consumer will definitely have the disease, nor does a low genetic risk equate with health and no risk of disease. Additionally, not all pathogenic variants are tested, so the consumer may not get a complete picture of their risk for disease.

Consumers may feel anxiety when receiving positive test results, while favorable, negative test results may falsely allay fears. There may also be confusion about the significance of results and how the information can be integrated into their future healthcare goals. Consumers may use social media and online communities to share their experiences and connect with others to discuss their results. As new information is learned about the significance of particular test results, updated information may present the consumer with more dilemmas on risk of disease, and how to address the new information.

Another potential risk of DTC testing is follow-up testing in the healthcare setting. If consumers receive abnormal or unexpected results from a DTC company, they may contact their PCP for guidance. This can lead to repeat or confirmatory tests at additional costs and labor that may not be covered by the patient’s insurance. These considerations and other potential risks are outlined in Table 2.

### CONCLUSIONS

DTC testing has benefits and risks as with clinical laboratory tests. Laboratory testing in the clinical setting is under tight regulation with laws and policies in place to help ensure tests meet analytical performance and clinical claims. In the clinical setting, qualified medical professionals are involved at each step of the process, from the examination of the patient and ordering of tests, to interpreting results and implementing treatment. In the healthcare setting, there is a provider to guide the patient through appropriate

**Table 2. Potential Risks of Direct-to-Consumer (DTC) Testing**

Privacy
Data can be released to third parties
Risk of data being compromised
Cybersecurity vulnerabilities, ransomware
Access and use by law enforcement
Denial of insurance benefits
Release of information on relatives who may not have consented
Results not protected by laboratory regulations
Technical Limitations
Sensitivity and specificity
Accuracy and precision
Different results with different methods
Sample tracking, integrity tracking, lack of “chain of custody”
Cost
DTC not covered by insurance
Some tests can be expensive
Confirmatory follow-up can be costly
Clinical Utility
Risk prediction versus disease diagnosis
Marketing could overstate utility
Lack of actionable information due to multiple factors that influence disease
Clinical Validity
Pretest probability
Risk accuracy
False positives and false negatives
Incorrect Diagnosis
Unnecessary lifestyle changes, surgeries, or procedures
Morbidity and mortality
Influence on family planning decisions
Overutilization
Repeating test in hospital lab to confirm
Unnecessary testing with higher false positives and negatives
Increased burden on healthcare resources
Provider–patient relationship
Distrust if DTC test does not agree with provider plan of care
Reconciliation of discrepant clinical and DTC results
Interpretation
Assistance with interpretation may not be available or provided
Company counselors may not be licensed, competent, or qualified
Emotional
Anxiety from test results
Confusion about significance of results
Community
May locate unknown family members
Disease communities/social identity may change if future result interpretation updated

test selection and interpretation of results based on the patient’s specific clinical condition. There are also greater protections for privacy and quality of laboratory testing. With DTC testing, consumers may not know the risks or what significance a result has in terms of current and future health. It is challenging for consumers to distinguish tests



**Figure 3.** Types of specimens collected for direct-to-consumer (DTC) testing from the most convenient and least invasive to the least convenient and most invasive.

for health and wellness from entertainment and commercial marketing. This can leave consumers open to misdiagnosis and susceptible to unproven treatments and questionable claims for cancer and disease cures. DTC tests are both an opportunity for an individual to better participate in their

health and in the management of chronic diseases, as long as consumers are aware of the risks for inappropriate utilization and inadvertent interpretation that can lead to avoidable follow-up, unnecessary procedures, and additional costs of care. DTC testing is an emerging field and an opportunity for laboratory experts to participate through providing professional advice, consultation on test limitations, interpretive services, and recommendation on optimal test utilization.

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