

ExomeDx Rapid: Exome Sequencing with a Rapid Turnaround Time

DESCRIPTION

The ExomeDx Rapid test is exome sequencing with an expedited turnaround time (TAT). This test is best suited for patients whose medical management may be altered by having a rapid molecular diagnosis. When variants selected for reporting require confirmation, a provisional result including pathogenic and/or likely pathogenic variants in known disease-causing genes definitively explaining the patient's phenotype is provided. A final, written report including all potentially clinically relevant variants from analysis of the exome will be issued within the expedited TAT. Clients will be notified of any updates regarding diagnostic variants between the provisional result and written report.

Because of the rapid TAT for this test, samples from the proband and both biological parents should be submitted at the same time, along with clinical information. If all of the required information and/or samples are not available at the time the proband's specimen is submitted, please inform us by emailing RapidTesting@GeneDx.com.

Exome sequencing (ES) can be used to identify the underlying molecular basis of a genetic disorder in an affected individual with:

- One or more congenital anomalies (PMID: 34211152)
- Unexplained epilepsy (PMID: 36281494)
- Unexplained hypotonia (PMID: 35254387, 31780822)
- Neurodevelopmental disorders including developmental delay (PMID: 31182824)
- A phenotype suggestive of a genetic etiology that does not correspond to a specific condition for which genetic testing is available (PMID: 35947384, 22863877)
- A suspected genetic condition that has a high degree of genetic heterogeneity (PMID: 22863877)

This test targets the protein-coding regions (exons) of ~20,000 genes, which account for approximately ~2% of the human genome (PMID: 21946919). These targeted regions are captured, sequenced using next-generation sequencing, filtered against published reference sequences, and compared to other sequenced family members, population databases, and control sequences to reveal potentially reportable variants. The affected individual's sequence is then evaluated using gene-phenotype associations, in conjunction with multiple resources including gnomAD, HGMD, OMIM, PubMed, and ClinVar (PMID: 26633542). Sequence changes of interest are interpreted according to the American College of Medical Genetics and Genomics guidelines (PMID: 25741868).

The clinical sensitivity of exome sequencing depends, in part, on the proband's clinical phenotype. Several large studies including those with critically ill infant populations have demonstrated that exome sequencing identifies a causal variant in 25–58% of cases, with a higher yield for cases that specifically include other biological family members (PMID: 31780822, 31182824, 35947384, 22863877, 25356970, 25326637).

For the analysis, an affected individual's submitted clinical records and previous genetic testing results are reviewed prior to analysis. The proband's analysis includes evaluation of variants that are identified to be de novo (when both biological parents submitted), compound heterozygous (when both biological parents submitted), homozygous, heterozygous and X-linked. In addition, analysis takes into consideration family

structure, reported phenotype, and provided clinical and/or differential diagnosis. This is a comprehensive analysis of a very large number of genes; therefore, reported results are focused on pathogenic and likely pathogenic variants, along with clinically relevant variants of uncertain significance, in genes related to the provided clinical information. Rarely, pathogenic, likely pathogenic, and molecularly strong variants of uncertain significance in genes known to cause pediatric morbidity or mortality may be reported.

RESULTS REPORTING

Exome sequence analysis is performed on the affected individual (i.e., the proband) and, when submitted together for analysis, biological parental samples, and/or additional biological relatives as needed. A report will be issued only for the proband. A separate report will not be issued for parents or other family members who may also have submitted a specimen for the purpose of allowing better interpretation of the results for the affected individual. If additional reports are requested for other affected family members, additional fees will apply.

The report issued for the proband may contain variations in genes previously implicated in a human disease that has clinical features similar to those in the affected individual or in genes hypothesized to be related to the cause of the disease (candidate genes or genes of unknown significance). Variants in candidate genes may be reported based upon limited published evidence and/or internal data, such as observations of previous patients with similar phenotypes and types of variants in the same gene. In addition, other evidence such as gene function, tissue of expression, and phenotype of model organisms with alterations in the gene may also be used as evidence to support reporting a variant in a candidate gene.

ACMG Secondary Findings

The American College of Medical Genetics and Genomics (ACMG) recommends that secondary findings identified in a specific subset of genes associated with medically actionable, inherited disorders be reported for all probands undergoing exome or genome sequencing. Please refer to the latest version of the ACMG recommendations for reporting of secondary findings in clinical exome and genome sequencing for complete details of the genes and associated genetic disorders. Secondary findings will be included for all exome or genome sequencing reports, unless a family opts-out of receiving this information on the Informed Consent as part of the test requisition form. The status of any secondary finding(s) reported for the affected individual will be provided for all relatives included as part of the proband's test; GeneDx does not conduct an independent evaluation of secondary findings in relatives. Relatives have the ability to opt-out of receiving secondary findings. Secondary findings will be confirmed by an alternate test method when needed.

TEST METHODS

Using genomic DNA from the submitted specimen(s), DNA is enriched for the complete coding regions and splice site junctions for most genes of the human genome using a proprietary capture system developed by GeneDx for next-generation sequencing with CNV calling (NGS-CNV). The enriched targets are simultaneously sequenced with paired-end reads on an Illumina platform. Bi-directional sequence reads are assembled and aligned to reference sequences based on NCBI RefSeq transcripts and human genome build GRCh37/UCSC hg19. Data are filtered and analyzed to identify sequence variants and most deletions and duplications involving three or more coding exons. Smaller deletions or duplications may not be reliably

identified. Reportable variants include pathogenic, likely pathogenic, and variants of uncertain significance; likely benign and benign variants, if present, are not routinely reported. Carrier status for the proband is not reported unless associated with the provided phenotype. Reported variants are confirmed, if necessary, by an appropriate orthogonal method in the proband and, if submitted, in selected relatives. Sequence variants are reported according to the Human Genome Variation Society (HGVS) guidelines. Copy number variants are reported based on the probe coordinates, the coordinates of the exons involved, or precise breakpoints when known. Available evidence for variant classification may change over time and reported variant(s) may be reclassified according to the ACMG/AMP Standards and Guidelines (PMID: 25741868), which may lead to issuing a revised report.

LIMITATIONS

This test attempts to evaluate the most important regions of the majority of the ~20,000 genes in the human genome. However, it is not technically possible to capture and sequence the entire exome at present. It is anticipated that approximately 98% of the targeted region of an affected individual's exome will be assessed at a minimum of 10x coverage, the minimum read depth necessary to detect a variant. Across the exome, the average depth of coverage is 100–120x. The test report will include case-specific exome coverage. There may be some genes or portions of genes that are not amenable to capture, sequencing, and alignment. Additionally, certain types of sequence variations are difficult to identify using exome sequencing, such as repeat expansions. In some instances, CNV detection may not be possible using the available sequencing data, and if so, this will be indicated in the final report. Average read depth statistics for exome sequencing tests are as follows:

Read Depth	10x	20x	30x	40x	50x
Mean Percent of Target Covered	98%	98%	97%	95%	91%

The available scientific knowledge about the function of all genes in the human genome is incomplete at this time. It is possible that these tests may identify the presence of a genetic variant in the exome sequence of an affected individual, but it will not be recognized as causative for the affected individual's disorder due to insufficient knowledge about the variant or the gene and its function. Reanalysis of the exome data is available upon request by the healthcare provider to incorporate updated clinical information and/or newly emerging gene and variant information. Updates to the classification of a sequence variant may be accessed through ClinVar (www.clinvar.com). Even if these tests identify the underlying genetic cause of a disorder in an affected individual, it is possible that such a diagnosis will not permit an accurate prediction of the prognosis or severity of the disease. While there is a possibility that identifying the genetic cause may help direct management and treatment of the disease, it is also possible that this knowledge will not change management or treatment.