

Exercise-Induced Collapse (EIC) Interpretation

Clear (N/N): A clear dog has two copies of the normal *dynamain 1* (DNM1) gene and therefore is extremely unlikely to be susceptible to the classic syndrome of d-EIC (DNM1- associated exercise-induced collapse). However, this result does not rule out the possibility that a dog could have a collapse condition that is different from the condition most Labrador Retrievers have.

Carrier (E/N): A carrier dog has one copy of the normal form of the DNM1 gene and one copy of the mutated form of the gene associated with d-EIC susceptibility. A carrier will ON AVERAGE pass the d-EIC gene on to half of their offspring. Our research indicates that two mutated copies of the gene are required for d-EIC susceptibility. Although, a small percentage of carrier dogs have collapsed under instances of intense exercise and/or excitement/stress, the percentage of carrier dogs with a reported collapse is no different from that seen in clear dogs. It appears that the vast majority of these collapses can be attributed to other medical conditions, or their signs are not consistent with the classic signs of d-EIC (see Further Information). At this time we have no evidence for association of carrier status and d-EIC.

Affected (E/E): An affected dog has two copies of the DNM1 gene mutation and is therefore highly susceptible to episodes of d-EIC. Your dog will pass a copy of this mutation on to all of their offspring. Some dogs have died during an EIC episode so we recommend that you have your dog stop exercising at the first signs of any weakness or wobbliness, and that you have them avoid collapse "triggers" such as hunt test and field trial training, or upland game hunting. Dogs with susceptibility to d-EIC can often perform mild to moderate exercise without collapsing.

Further Information: Research at the University of Minnesota has identified a genetic mutation that is highly associated with EIC susceptibility. This discovery was published in the October 2008 issue of Nature Genetics, one of the most highly regarded journals of genetic research. The article can be found under the following citation:

Patterson EE, Minor KM, Tchernatynskaia AV, Taylor SM, Shelton GD, and Mickelson JR. (2008). A canine dynamin 1 (*DNM1*) mutation is highly associated with the syndrome of exercise-induced collapse. Nature Genetics 40, 1235-1239.

We are testing for a single DNA base pair change in a specific gene, the DNM1 gene; therefore this can be referred to as a gene mutation test. We now refer to the collapse condition that results from this mutation as DNM1- associated exercise-induced collapse, or d-EIC, to distinguish this specific genetic cause of collapse during exercise from the many other potential causes of collapse during exercise. d-EIC affected dogs can tolerate mild to moderate exercise, but 5 to 20 minutes of strenuous exercise with extreme excitement induces weakness and then collapse. Severely affected dogs may collapse whenever they are exercised to this extent - other dogs only exhibit collapse sporadically.

The first thing noted is usually a rocking or forced gait. The rear limbs then become weak and unable to support weight. Many affected dogs will continue to run while dragging their back legs. Some of the dogs appear to be in-coordinated, especially in the rear limbs, with a wide-based, long, loose stride rather than the short, stiff strides typically associated with muscle weakness. In some dogs the rear limb collapse progresses to forelimb weakness and occasionally to a total inability to move. Muscles are relatively flaccid during collapse, although when restrained in lateral recumbency some dogs exhibit increased extensor tone in the forelimbs. Manipulation and palpation of the muscles, joints, and spine during or after an episode does not seem to cause discomfort. Affected dogs always completely lose their patellar reflexes during collapse and for a short period of time during recovery - even while they are able to walk relatively normally.

Some dogs appear to have a loss of balance and may fall over, particularly as they recover from complete collapse. Most collapsed dogs are totally conscious and alert, still trying to run and retrieve during an episode but as many as 25% of affected dogs have had at least one episode where the owner reports that they appear stunned or disoriented during the episode.

It is common for the symptoms to worsen for 3 to 5 minutes even after exercise has been terminated. **NOTE: A few affected dogs have died during exercise or while resting immediately after an episode of exercise-induced collapse; an affected dog's exercise should ALWAYS be stopped at the first hint of incoordination or wobbliness.**

Inheritance

We have designated the letter E to indicate the mutant (EIC) form of the DNMI gene and N to indicate the normal form of the gene. A dog's particular combination of N or E forms of the gene is known as its genotype. The genotype of a normal dog is designated as N/N and is clear of the mutation. The genotype of a d-EIC carrier is designated as E/N, and the genotype of a d-EIC affected dog is designated as E/E.

d-EIC is inherited in an autosomal recessive fashion; therefore both parents must be either carriers (E/N) or affected (E/E) to produce a puppy with d-EIC. The average expected results for each mating possibility are as follows:

* Clear (N/N) x Clear (N/N) = 100% clear (N/N)

* Clear (N/N) x Carrier (E/N) = 50% clear (N/N), 50% carrier (E/N)

(This is an average, individual litters may see anywhere from 100% clear to 100% carrier)

* Clear (N/N) x Affected (E/E) = 100% carrier (E/N)

* Carrier (E/N) x Carrier (E/N) = 25% clear (N/N), 50% carrier (E/N), **25% affected (E/E)**

(This is an average, individual litters may see more or less of any result)

* Carrier (E/N) x Affected (E/E) = 50% carrier (E/N), **50% affected (E/E)**

(This is an average, individual litters may see anything from 100% carrier to 100% affected)

* Affected (E/E) x Affected (E/E) = **100% affected (E/E)**

Current data from more than 30,000 Labradors shows that more than 35% of Labrador retrievers are d-EIC carriers; therefore, we do not recommend selecting dogs for breeding based solely on their being N/N for the DNMI gene. Such a drastic strategy, although more quickly eliminating the possibility of producing E/E and d-EIC affected dogs, also has the undesired result of potentially losing many of the outstanding exercise and performance traits expected of many superior lines of Labrador Retrievers. A breeding program that utilizes E/N or even E/E dogs can be logically implemented by mating to N/N dogs and retaining E/N or N/N puppies for future breeding that also retain most or all of the other highly desired characteristics. There is no chance of producing an E/E puppy if it is known that at least one of the parents is N/N. In general, we recommend matings that produce fewer carrier (E/N) dogs in each successive generation.

For current carrier rates of various breeds, see "[Breeds Tested & Carrier Frequencies.](#)"

Outlook and Treatment

Dogs with the E/E genotype and exhibiting signs of d-EIC are often unable to continue training or competition. The best treatment in most dogs consists of avoiding intensive exercise in conjunction with extreme excitement/stress, especially in warm temperatures, and ending exercise at the first sign of weakness/wobbliness. A few d-EIC affected male dogs have experienced improvement after neutering - with an improved ability to tolerate intensive exercise without collapse.

If a d-EIC affected dog does collapse, (1) make sure that it has unobstructed breathing so it can hyperventilate to blow off heat, (2) offer water and ice orally, and (3) cool the dog by immersing it in cool water or wetting it down. Enforce rest until the dog is fully recovered.

For additional information please refer to the following website:

<http://www.vdl.umn.edu/services-fees/canine-neuromuscular-eic>

***** Disclosure of financial interests: This test was developed through financial support from the AKC Canine Health Foundation. **To date, proceeds from EIC testing at the University of Minnesota have returned more than \$175,000 to the AKC Canine Health Foundation to further its mission to improve the health of all dogs.** Drs. Mickelson, Patterson, and Taylor; and Minor, RN are the inventors of the d-EIC test, and receive a portion of testing proceeds.