Early Adult Onset Deafness Testing and Research

Background:

In partnership with University of Helsinki and Dr. Hannes Lohi's research laboratory, Wisdom Panel is pleased to offer a four marker risk panel for early adult onset deafness (EAOD) in the Border collie in its Optimal Selection™ Canine and MyDogDNA® tests. This disorder is devastating in that it causes hearing impairment or deafness in otherwise healthy adult dogs, usually diagnosed between the ages of 4 and 7 years, rendering traditional herding work difficult or impossible for them to perform, and often after they have produced puppies. This test is being offered before peer-reviewed publication in partnership with the primary researchers to expedite the search for the causative gene, and because the disorder is common and of great concern to the Border collie community.

About the disorder:

The EAOD test differs in several ways from the majority of genetic tests to which breeders have been accustomed. Firstly, the causative gene mutation has not yet been discovered, but the general DNA region has been identified, so the four markers are **linked**, meaning they are thought to be located close to the causative mutation, and therefore *almost always* inherited together. This is different from most Optimal Selection™ and MyDogDNA® tests, which are **direct** tests, meaning the assay specifically detects the presence or absence of the causative gene mutation. Also, four markers are used instead of one, so the results of all four markers are considered when reporting results.

Current understanding of the disorder is that it primarily follows an **autosomal recessive** inheritance pattern, meaning both parents need to donate the mutated gene for the offspring to develop deafness. University of Helsinki has noted the risk genotype appears to occur with equal frequency in purpose-bred show and working lines. It is not located on the sex chromosomes (X and Y). Results are reported as "clear," "carrier" and "at risk" genotypes, meaning neither, one, or both parents likely donated the mutated gene, respectively. Importantly, this mutation is hypothesized to show **incomplete penetrance**, meaning an "at risk" result for EAOD indicates that the dog has elevated risk of early onset hearing loss, but the amount of hearing loss and the age of onset is dependent on additional factors. Translated, this means that some dogs with the "at risk" genotype might not experience any hearing loss, or might just have slight hearing loss later in life. This mutation could be similar to the *BRCA1* mutation in humans, which is associated with an 80% lifetime risk of breast cancer. Incomplete penetrance can only be determined conclusively once the causative mutation is known. When a genetic mutation only causes disease in some cases, it is thought that other genes, conditions or triggers must be present to cause disease. Examples of conditions or triggers include stress, hormonal status (e.g. intact/neutered/pregnancy), nutrition, infections, etc. These factors in EAOD are yet to be determined.

Wisdom Panel Findings:

Thus far, Wisdom Panel has noted a 31% carrier rate for this four marker linked test in the Border collies we have tested worldwide. 7.5% of dogs tested with Wisdom Panel have been found to have the at risk genotype, and based on the initial indications of incomplete penetrance, not all of those dogs will go on to develop deafness, so dogs affected with the disorder account for 7.5% or less of the total population. This may reflect a population testing bias, meaning those with EAOD deafness in their lines are more likely to

perform the test than those who do not. Although these are early findings for a linked marker test, it does suggest the mutation is quite common in the Border collie. Therefore, it is of paramount importance in responsible breeding management that the goal be a *slow reduction* in frequency of the risk genotype over many generations, rather than a single-generation exclusion of all carrier or at risk dogs, to avoid a genetic bottleneck in the breeding population as a whole.

Wisdom Panel, University of Helsinki, ABCA and ABCA HEF are aligned in the following recommendations for breeding programs:

- **Breedings should be planned so that no at risk genotype dogs are produced**. Carrier and at risk genotype dogs *can and should* continue to be used, but care should be taken to breed to clear dogs in those cases, with all the other normal considerations for breeding. In this way, valuable breed line genetics are preserved, and puppies have a reduced risk of development of disease.
- **Carriers**: **It is most responsible to continue to use carriers in your breeding programs** assuming the dogs are otherwise excellent examples of the breed, but care must be taken to breed them to normal hearing, clear genotype dogs. Subsequent carriers should slowly, over many generations, be replaced with clear genotype dogs, by testing of all puppies. A person's worth is not defined by one genetic test; similarly, there are many valuable genes and features a dog brings to the breed, not just their EAOD genotype. Because the carrier rate is quite high, at nearly 1/3 of the dogs, if all Border collie breeders chose to not breed carriers, the breed gene pool would be catastrophically reduced, causing far more damage to the breed than the disorder itself.
- **At risk dogs: At risk genotype dogs can also continue to be used in breeding programs** if they are otherwise excellent examples of the breed, but care must be taken to breed them to normal hearing, clear genotype dogs so no at-risk puppies are produced.
- **Puppies: All puppies of parents who tested as carrier or at risk genotype should be tested**, as litters will likely have both carrier and clear genotypes present, and testing one puppy will not be representative of the whole litter.
- **Clear by parentage:** As with other types of disorders, it is wise to check breeding dogs assumed to be clear by parentage every few generations.

How you can help:

Get your EAOD carrier and at-risk dogs BAER tested:

To participate in the research of EAOD in the Border collie, Wisdom Panel asks Border collie owners to share the Brainstem-Auditory-Evoked-Response (BAER) test results for their dogs tested with Optimal Selection™ Canine or MyDogDNA® tests if they have the at risk genotype, whether or not they are deaf, or the carrier genotype, by filling out the following form, and uploading BAER results:

https://wisdomhealth.typeform.com/to/HGHdUY

BAER testing is essential to prove actual hearing loss (clinical verification of the disease), and can be performed at most veterinary colleges and neurology specialist offices. Additional testing locations may be found here: https://www.lsu.edu/deafness/baersite.htm . By sharing BAER testing results for *both* normal hearing and deaf dogs with the at risk genotype, Border collie owners help to establish the degree of risk or penetrance to be expected. Wisdom Panel tracks this information, and with owner permission, shares archived DNA and reported individual and family history and BAER results with University of Helsinki. When seeking BAER testing, please ask for sedation or anesthesia, as fully awake dogs can render results invalid.

Also specifically ask for *both* 80 decibel (dB) and 50 decibel tests. University of Helsinki researchers have found that 50dB testing is very useful in picking up early hearing loss, but isn't always normally performed.

Dogs who have not been tested, and were confirmed deaf by BAER testing between the ages of 4 and 7 years of age, AND with normal BAER testing between the ages of 6 weeks and 4 years, are eligible for free testing with Wisdom Panel, provided the information can be shared with University of Helsinki. Please complete the above form (https://wisdomhealth.typeform.com/to/HGHdUY), and if determined eligible, Wisdom Panel researchers will provide you with a testing kit.

Our Goals:

We at Wisdom Panel are dog lovers and have been pioneering canine genetic health for more than 15 years. Our sincere hope is that by offering this testing during the research phase, in partnership with University of Helsinki, that we may help to expedite the research process, as we have done on many joint research projects in the past. We also chose to provide early screening services to help avoid producing dogs with this sad disease, by request from by the Border collie community. We would like to emphasize that to positively and holistically manage and monitor prevalence of this genetic disease in the population, at risk and carrier genotypes should continue to be used responsibly as described above. Disorder testing should never cause more damage than good, so we trust Border collie breeders will keep the big picture in mind when incorporating yet another tool into their breeding toolbox.

The collective primary goal at this time is to determine the causative gene for EAOD. University of Helsinki is making progress to this end, and to speed this effort, emphasize a need for BAER testing results for all DNA tested carrier and at-risk dogs.

The secondary goal, which is also assisted by additional BAER testing results, is to determine the degree of risk or penetrance; that is, for those dogs who do have an at-risk genotype, how likely are they to go on to develop hearing impairment or loss, so owners and breeders know what to expect.

Publication of this research in a peer-reviewed journal is planned to occur within the next year.

Any questions or feedback are welcome, at info@wisdomhealth.com for Optimal Selection™ and MyDogDNA®, or for the University of Helsinki Lohi Research Lab, marjo.hytonen@helsinki.fi . We thank the ABCA, ABCA HEF, University of Helsinki, and Border collie breeders worldwide for making this research possible.

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