INTERNATIONAL ELBOW WORKING GROUP

IEWG

PROCEEDINGS

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1999 IEWG Protocol
(Editor's note-1999 protocol accepted without change at IEWG2000.)
http://www.vetmed.ucdavis.edu/iewg/iewg.htm.

Welcome at the IEWG-2000 Congress

The International Elbow Working Group (IEWG) was founded in 1989 at a meeting in Davis, CA, by an international group of six veterinarians with expertise in elbow disease [Lars Audell, Mark Flückiger, Jorunn Grondalen, George Padgett, Lennart Swenson] , a statistician [Mathias Weis] and a physicist [Martin Packard] whose wife was active in the 'purebred dog world'.

The IEWG has met around the world: San Francisco (1990), Vienna (1991), Rome (1993), Philadelphia

(1994), Constance (1995), Birmingham (1997), Bologna (1998) and Orlando (1999). The IEWG-2000 congress is this year organized in conjunction with the global and European organizations of veterinarians, and its hosting national veterinary congress organization: the World Small Animal Veterinary Association - Federation of European Companion Animal Veterinary Association - Voorjaarsdagen Congress Committee in Amsterdam. These meetings offer an opportunity to exchange knowledge about elbow dysplasia (ED) and to focus with the veterinary profession a battle against this wide spread threat to many popular dog breeds.

Numerous countries have made a start to screen elbow joints of breeds at risk for ED. The IEWG offers their Protocol for screening programs via the website of the IEWG: http://www.vetmed.ucdavis.edu/iewg/iewg.htm. At recent IEWG-meetings papers have been presented which show that there has been a decrease in the incidence of ED when breeders make educated breeding decisions based on screening results. It is predictable, that the incidence of ED decreases significantly when breeding measures are installed when dealing with breeds with a high incidence of ED. However, as the incidence of ED is decreased because of these measures, breeders may become discouraged because progress begins to slow.

Speakers with international reputation in the field of genetics were invited to the IEWG-2000 congress to discuss the subject of breeding in populations at risk for hereditary diseases. Techniques, consequences and their pro's and con's will be discussed on topics ranging from the collection of phenotypic data, the calculation of likelihood of estimates for genotype, or accurate DNA determination.

A representative of the Federation Cynologic International and the chair of the club which is most active in screening for ED in The Netherlands, will present the issues from the perspective of both the international and the individual clubs to organize, harmonize and certificate screening for ED. There is appreciation for the fact that 'free phenotype' for an individual dog does not give information about the 'genotype' to produce offspring with a high chance of developing ED.

The decisions which strategies have to be chosen for, are even more complicated when different breeds are screened not only for secondary osteoarthrosis but also for the primary diseases leading to ED, i.e., fragmented coronoid process, osteochondritis dissecans, ununited anconeal process and incongruities. Although it has been shown that the syndrome ED is inherited according to a polygenic model, the individual primary disease may reveal to be a monogenetic disorder, recessive in some breeds and even dominant with reduced penetrance and/or variation in expression in others. This warrants a divers approach to elucidate ED in that particular breed. These dilemma's will be discussed during the congress.

The organizers of the IEWG-2000 congress are extremely grateful to the invited speakers who have come to the RAI-congress center to present their papers, to the colleagues who have taken the effort to present a poster on ED during the congress, and to the attendees for their interest shown in the Elbow Working Group.

I would also like to acknowledge the kind support from **Iams Pet Food International** , **Intervet International bv** and the Dutch Kennel Club (**Raad van Beheer op Kynologisch Gebied**) by their financial donations.

The IEWG invites all interested veterinarians to join the Group by subscribing the membership during the congress or later as outlined on the website http://www.vetmed.ucdavis.edu/iewg/iewg.htm.

Welcome to the IEWG-2000 congress, with wishes for an enjoyable stay in Amsterdam, both

scientifically and socially.

H.A.W. Hazewinkel

IEWG-2000 congress committee

IEWG President's Message:

First let me welcome you to Amsterdam in the spring of this new century, as we look at the role not only of IEWG but also of Veterinary Medicine in the coming new millennium and how each of us will influence or be influenced by the changes which we make during this meeting.

When 1 became President of IEWG in Bologna I had two major goals. The first was for our organization to be recognized and accepted into affiliate membership in the WSAVA, a project that I started as vice-president. Shortly after 1 became President the honorable secretary, Maggie Gething, informed us, that the Executive Board of the WSAVA had given provisional membership to five national associations and IEWG. At the Assembly meeting in Buenos Aires on October 6, 1998 we were accepted into full affiliate membership status. The second goal was for us to have representation on the Hereditary Defects Committee of the WSAVA; President Klaus Dreier completed this goal with my appointment to the committee at the meeting of the WSAVA in Lyon in September of 1999.

At the time of this writing we have 77 members, representing 22 countries. In January of 1999 we held our annual meeting in conjunction with the North American Veterinary conference in Orlando, Florida. The papers that were presented there were of excellent quality, as always, but unfortunately we did not have a quorum at the business meeting and all action was postponed until the meeting to be held in Amsterdam. The WSAVA meeting in Amsterdam will be of extreme importance as we will be making decisions which will affect the future direction of the IEWG.

Association with the WSAVA carries both responsibility and the possibility to expand our influence beyond the confines of academic medicine, from the realm of surgery and radiology to the realm of genetic counseling and to the world through education and the development of international registration. These areas have consumed much time and effort of many of us and now may become a reality within the next few years,

This year in Amsterdam we will explore data analysis as a tool for genetic counseling and how it applies to Elbow Dysplasia. The information gleaned from this meeting will be valuable for the control of other genetic defects such as Hip Dysplasia as well as some non-orthopedic diseases. For the first time the IEWG brochure was translated into another language, Italian, and will be distributed in the year 2000. This was accomplished through the efforts of two of our members, Professor Mortellaro and Dr. Petazzoni, working with Dr. Marina Debemardi of Hills Pet Food. lt is my hope that this is just the first of many translations, which will aid in the standardization of elbow evaluation and the acceptance of an international registration form.

We must decide not only the standards for Elbow Dysplasia certification but also what recommendation should be made for those changes that are seen, peripheral to the elbow joint. The recommendations of the Executive Meeting from January 8 in Orlando need to be approved. We must determine if we are to

meet each year with the WSAVA or will we hold our annual meeting at another time and place and yet continue to participate with the WSAVA and influence the direction of the Hereditary Defects Committee. Since President Dreier and the Executive Board of the WSAVA desire to maintain continuity on the various committees, 1 need your endorsement if you wish for me to continue to represent IEWG on the Hereditary Defects Committee.

I extend my best wishes to our new President Herman Hazewinkel, and to the other officers who will be installed after the scientific meeting in Amsterdam. 1 would also like to take this opportunity to express my personal gratitude and that of the working group to the years of service of our cofounder and secretary Barbara Packard on this, the year of her retirement. lt has been a pleasure for me to work with Barbara. The world veterinary profession owes her and her husband Martin Packard a vote of gratitude for what they have done through the establishment of both the International Elbow Working Group and the Institute for Genetic Disease Control in Animals (GDC) in America.

lt is my sincere hope to see all of you at the next WSAVA meeting which will be held in Vancouver, British Columbia, Canada, August 8 - 11, 2001. I pledge my continued support to IEWG and hope to continue the efforts to establish a truly internationally acceptable form for registry of Elbow Dysplasia as well as additional translations of our brochure into many other languages.

Sincerely,

Paul W. Poulos. Jr., DVM. Ph.D.

President of IEWG

ELBOW DYSPLASIA, SCREENING AND SCORING SYSTEM

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A young Golden Retriever dog with a suspected osteochondrosis dissecans in the elbow joint was operated in Stockholm in 1973. A caudal approach via an osteotomy of the ulna was performed, since a thorough radiological examination including arthrography had only shown a small cartilage lesion in the humeral condyle. The dog improved after surgerv, but was put to sleep two years later due to severe lameness caused by arthrosis in both elbow joints. A postmortem examination revealed that the dog also had fragmented coronoid processes in both elbows joints. This old history emphasizes the problems we still have with identifying and classifying small lesions in and around the coronoid processes using traditional radiographic methods. New projections and improved skills in reading radiographs have reduced earlier high numbers of false negatives, hut we still see a significant number of small lesions in

and around the coronoid processes at arthroscopy, surgery or necropsy, lesions which have not been diagnosed with certainty on earlier radiographic examinations. Estimation of elbow joint incongruity has been proven to be a valuable clinical information in a few breeds, but absence of strict grading criteria and as of now rather big inter-reader differences has made it less valuable when it comes to routine radiographic screening of "normal" dogs.

These old problems with a significant number of false negative and also some false positive screening results compared to results using different invasive methods were the reasons why researchers in both Norway and Sweden decided to try other screening criteria. They found, already in the 70's. that at that time radiographic signs of secondary arthrosis, although not specific regarding the different lesions in the joint, were the most reliable and most consistent signs of elbow disease in screening programs for many breeds. This rather simple screening system has now been used for almost ten years in many countries and the results are comparable and promising and the inheritance in the most affected breeds is convincing. In Sweden more than 60 000 dogs of 120 different breeds have had their elbows radiographed and screened and the results in the most affected breeds look promising. In the Rottweiler breed a reduction is seen in the prevalence of elbow arthrosis from over 60% down to 30% after 20 years of strong efforts from breeders and involved veterinarians. In the Bernese Mountain Dogs a reduction from over 50% down to 25% has been achieved in less than 15 years. lt must however be pointed out that the main reason for the success in reducing the prevalence of elbow arthrosis in these two breeds are not due to the specific diagnostic criteria nor to the reading skills of the radiologist. The main reason is the unique interest from and cooperation with owners and breeders and the loyal veterinary profession that sends almost all radiographs for central screening, without pre-selection. With more than 80% of all registered dogs in these two breeds controlled and all results, good or bad, in the public domain, it appears as if the simple radiographic technique and the rather simple and inexpensive screening procedure are sufficient and work well. In fact it could be discussed if they are not some of the main reasons why the hole program has such a good acceptance which in turn is the reason for the good results. The figures regarding German Shepherd Dogs and Golden and Labrador Retrievers do not yet show the same magnitude of success, but will be discussed in detail during the lecture.

ACTIVITIES BY FEDERATION CYNOLOGIC INTERNATIONAL (FCI) TO COMBAT ELBOW DYSPLASIA

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FCI is an umbrella organisation for the European and most other Kennel Clubs around the world. Within FCI an appointed scientific commission is dealing with genetics of inherited disorders and other aspects related to health and diseases in Dogs. Due to strong links in many countries between the national Kennel Clubs, the veterinary profession and Universities involved in canine research, issues like hip and elbow screening programs have been on the agenda since long time.

Workshops on Hip Dysplasia and Elbow Arthrosis was arranged by FCI in Dortmund 1991. It was concluded that screening programs for both should be performed in a uniform way in all member countries of FCI and that the procedure should be practical to perform and the results should be useful for the selection of breeding stock, by making them available openly to the public.

To promote screening for Elbow Arthrosis as well as hip dysplasia and the exchange of results from such screening programs, international elbow and hip certificate have been established. With regard to various national programs to screen it is proposed that an international certificate is a document, to be issued together with certificates of any national screening programs now operated in a specific county. It means that internationally exchangeable result is communicated besides any other screening results used within a national program.

With Elbow Dysplasia, as compared to hip dysplasia, so far less diversified programs have evolved. Thanks to good work within the IEWG, most screening programs operated for Elbow Dysplasia have several entities in common. An international certificate of hip and elbow status have to be based on something that existing and forthcoming panels are able to live up to regardless whether national programs are more or less extensive than that for the international certificate. Age at screening, mandatory projections and principles for the evaluation and scoring has be agreed on by IEWG.

It is proposed that the national kennel clubs are issuing the international certificates based on evaluations made by panels within a country that fulfil the criteria that have been set up for an international certificate. The Scandinavian Kennel Clubs have already prepared a prototype for such an international certificate, to be used for exchange of results with breeders in other countries, while at the same time continuing their own national screening programs in a fashion which have proved to be of great value in for example Norway and Sweden.

The international certificates for the result of screening for hips and elbows was formally approved by the FCI General Assembly in Mexico City in June 1999. The national panellists for hip and / or elbow screening are strongly urged to seek co-operation with their national kennel clubs referring to the above mentioned collaborations in an effort to put the certificates on the market as soon as possible after their approval by their cynological as well as professional organisations.

BREEDERS DEMANDS OF GENETIC COUNSELING IN RELATION TO ED

Roswitha Buytendijk-Lubbers, chairwoman Dutch Labrador Retriever Club

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The 'Nederlandse Labrador Vereniging' (NLV) was founded 35 years ago. Total membership: approx. 6600. The Labrador retriever has become very popular in Holland. In 1999 4.029 Labradors were registered and thus our breed headed the 'top 10' of the Dutch Kennel Club for the first time ever.

This immense popularity is a real threat to the well-being of each individual dog as well as of the breed in total as far too many breeders breed dogs that would not be bred if prices and demand were low. Important breed-specific features, such as temperament or working ability are not stressed enough when it comes to breeding: far to many newcomers do not seem to realize that a Labrador owes its popularity mainly to its temperament and will to please.

Now and than breeds are confronted by a 'new' hereditary disease. Of course it goes without saying that these 'new' diseases might have existed for much longer. Thanks to the popularity of one or two stud dogs that inherit the defective gene, an explosion of, for instance, elbow dysplasia occurs.

In February 1992 the NLV published an article on 'Elbow Dysplasia' and later on we decided to publish a booklet (revised edition was published in 1999).

In 1996 an at random-survey showed that 23.8% out of 150 Labrador retrievers showed signs of Elbow Dysplasia. Shortly the first legal procedures started and the judged ruled that it would be very inappropriate to breed 'dysplastic' animals. Moreover they stated that breeders that do not screen their stock or ignore its outcome, would be liable for damages. At the end of 1996 the Dutch W.K. Hirschfeld Foundation (WKHF) adviced the NLV not to breed affected elbows and in 1997 the Annual Meeting of the NLV agreed to take measures in order to fight the incidence of ED. Ever since the greater part (nearly everyone) of our club have their studdogs and broodbitches tested.

In 1999 443 Labrador retrievers were officially tested in Holland: 88,49% showed no signs of Elbow Dysplasia, 11.51% did. It seems fair to state that the greater part of these dogs will be bread, if and when the other compulsory health schemes show so signs of HD, for instance. Vets and specialists do not realize that breeding a decent Labrador has become increasingly difficult. There is not just one trait we have to trace! Nowadays any breeder has to radiograph hips as well as elbows. In addition, the eyes of any broodbitch or stud dogs have to eye-certified yearly. The total costs can be estimated at ƒ2500.- (> $1000), stud dog-fee included.

I'm not here to lament any breeder, I just care for the breed and so do many of our members, most breeders included. Breeding is a hobby -should be at least. However: as long as quite some specialists are mainly or even just interested in their own field of interest, the breed will suffer: it will harm the gene pool even further if we are trying to find the perfect dog, thus expelling second best dogs and throwing their genes in the dustbin. The perfect dog does not and will never exist. Nor does the perfect wife!

Any dog is entitled to a decent life and should not fall apart at the front door at its first arrival, but in

order to achieve that we need to be able to have far more dogs (offspring) tested. To be honest: we cannot as the prices are sky high. Of course it's interesting to reach for the sky, but wings of wax melt…

As the advantages of the system of breeding value estimation emerge, an increasing number of members/breeders will wonder why on earth we have not started yet. If any breed club could invest a certain amount of money into a breed value estimation programme on lets say Elbow Dysplasia by raising money from members by convincing them this method will work, there might be a much faster progress. We will have to abolish the very expensive screening programma: it is not very realistic to expect people to pay heaps of money whereas their Labrador-friends living abroad are free to use a much cheaper programme giving a much better overall-picture due to the huge numbers of dogs examined.

To breed sound dogs we need as much info on hips, elbows and eyes. This should be affordable. The results must be available to the public, costs have to be cut drastically, and: breeders are fed up with the still existing differences of opinion between one specialist in lets say Germany and Holland. They do not understand why there is still no international agreement on hips and elbows protocols.

Internet has already changed the world of dog breeding. It's not up to me do decide whether it's for the better or for the worse, but international contacts show the differences quite clearly. The introduction of the system of breed value estimation as well as the reduction in costs should do the trick.

Results have to be published, breed clubs should be counselled by an independent genetic expert and should be supported by vets in lowering the costs. If they do not, breedclubs will take the liberty to try to draft contracts by certain specialists.

We have to know much more to be able to eradicate the 'bad' genes. So far, we have done too poorly.

ELBOW DYSPLASIA IN A RADOMIZED POPULATION OF GERMAN SHEPHERD DOGS; RESULTS OF DIFFERENT SCREENING METHODS

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Introduction. The objective of this study was to determine the prevalence of elbow dysplasia (ED) among a population of the "Association of German Shepherd Dogs" in Germany. The results of different screening methods were tested for their heritability as a basis for selective breeding.

Materials and Methods. 500 dogs were selected by the "Association of German Shepherd dogs" (SV) at an age of about 12 weeks by a random computer program on the basis of their registration number. X-rays of the elbows were taken using a mediolateral flexed and craniocaudal projection at about six months of age (A-study) and a second radiographic examination was performed at a minimum age of one year (B-study). The A-study contained 443 selected dogs of which 363 were re-examined in the B-study. The elbows were scored 1) according to the rules of the IEWG by two different readers, 2) by only one reader, introducing a "borderline" grade, and 3) according to the more extended protocol published by Lang et.al. (Proceedings of the 7th annual meeting of the IEWG, 1995). Genetic analysis was performed by variance component estimation.

Results. In the younger dogs (A-study) we found 16.5% elbows with arthrosis of grade I and II (IEWG). 5.2% of the dogs showed an IPA (UPA), 2.5% a FCP or were highly suspicious for FCP and 0.5% an OCD. In the B-study the frequency of elbow dysplasia was found between 30% and 47%, depending on the method of interpreting the radiological signs in the elbows. The frequency of IPA was lower (3.3%) because nearly half of the dogs with a diagnosed IPA in the A-study did not contribute to the B-study. The occurrence of FCP increased to 5.3%, OCD alone has been dedected only in one case (0.3%). In 10 dogs (2.8%) arthrosis of grade II and III was diagnosed without a detectable primary lesion. In a first estimation of heritability based on the IEWG score by the first reader, using a very strict interpretation of "arthrosis" in the elbows, heritability was found to be near zero. The more extended protocols for reading elbow radiographs shows higher levels of heritability.

Conclusions. In our material we found a relatively high frequency (>10%) of primary lesions in elbows of German Shepherd Dogs and in addition about 20% of dogs with arthrosis alone, mostly grade I. Compared to the finding of 30% heritability for arthrosis in Rottweilers , the German Shepherd Dog shows a significantly lower level. It should be discussed whether the IEWG score based only on the radiological findings of arthrosis can be used in all breeds as a basis for breed selection against elbow dysplasia.

BREEDING VALUE ESTIMATIONS IN DOG POPULATIONS

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This contribution gives an overview of the mechanism of breeding value (BV) estimation and the possibilities to use BV's for selection. The BV represents an animal's *heritable* characteristics and is based on observed characteristics of relatives. Importantly, an animal's *heritable* characteristics may be different from the characteristics *shown* by the animal (if shown at all). BV's (linear, non-linear, polygenic or monogenic) have been used for many years already in the genetic improvement of livestock and genetic counseling programmes for human diseases.

Many sophisticated extensions exists, for instance additional risk factors can be modeled, non-heritable environmental resemblance or heritable maternal influences can be corrected for, and different origins of animals (e.g. foreign herd books) can be included in the model, estimating a separate risk-level for each origin.

The procedures are very flexible and do not require a specific population structure to work, although the population structure may affect the efficiency of an improvement programme. For lower heritable characteristics, it is preferred to use mainly "proven" fathers wich have already produced some (test) litters. Also, progress will become slow when the incidence of a disorder becomes low, and in that case test matings with high risk females can be beneficial to increase efficiency.

Genetic improvement based on BV's is relatively cheap and quickly implemented, compared to for instance DNA-based predictions. Most important is the set-up of a continuous process of collection of information from breeders and redistribution of breeding values to breeders. An initial set of data (e.g. from one year) is needed to start up the system, and once running the system can be maintained on an "information for information" basis. Benefits should then become visible, if the breeders indeed use the BV's in their breeding decisions, in 2-4 years for medium heritable traits.

An example is given of a developed genetic counseling system for elbow dysplasia in Labradors. Without knowing the details of the inheritance, a well predicting system was developed using 188 initial records.

ELBOW DYSPLASIA GRADING IN CANINE POPULATIONS IN GERMANY

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The term elbow dysplasia (ED) describes the state of the elbow joint caused by abnormal development. The most common lesions in the elbow joint are the *fragmented coronoid process* (FCP), the *osteochondrosis dissecans* (OCD) and the *isolated processus anconeus* (IPA). All these (secondary) lesions as well as malformation itself can cause irreversible osteoarthrosis and can lead to lameness and pain.

The international grading system (IEWG 1998) is mainly based on the amount of secondary arthrotic changes in the elbow joint. The primary morphological malfunction can not be described by this system. Dogs are classified in 4 categories from which the first covers all those with no arthrosis while higher grades are proportional to the amount of osteophytes. The frequency of the ED grades differs from breed to breed, e.g. the rate of unaffected dogs is 45.8% in Rottweiler, 75.0% in Golden Retriever, 83,9% in Labrador Retriever and 69.7% in German Shepherd Dogs.

It is suggested by different authors, to solve the ED problems by screening and simple mass selection. Heritability, a parameter for the response to selection, is not high enough in order to ensure successful breeding over generations. Breeding value estimation, using information from relatives, are applied in some breeds, but the categorical trait makes practical application very difficult. The following points must be seen as severe disadvantages in practical breeding application. They however do not lower the importance of ED-scoring to characterise the health status of the dog.

*Arthrosis, and by this ED-grading, has different origin in different breeds. So heritability and mode of inheritance is different from breed to breed. Discarding Labrador with ED from breeding is wrong in male but useful in female (n=1694) while the offspring's ED depends equally on sire's and dam's ED in Rottweiler (n=2114). German Shepherd suffer from IPA which is inherited strongly while arthrosis without lesions are caused mainly by bad environmental frame conditions.

*ED is a categorical trait. More than 50 % of the variation is not differentiated. Dogs with excellent shape and functionality of the joint do not profit from that. The scale is not open!

*In most breeds Grade 3 is extremely seldom The total variance is covered by 2 intervals and breeding values are "jumping" in the course of time depending on the score of the new included sibling or offspring.

If there is a risk to get clinical symptoms, lesions and arthrosis, depending on the conformation and functionality of the joint, it seems to be necessary to describe this risk. First experiences to describe elbow quality (EQ) by means of measuring joint characteristics and weighting them to maximise the prediction of the breed specific genetic risk for ED, give hope for better usage in breeding.

RISK-ESTIMATES FOR PROGENY: BOTH VETERINARIANS AND BREEDERS COULD PROFIT !

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Introduction. In Companion animal practice, practitioners are confronted with individual animals, that are not in optimal health. Consultation and subsequent examination might result in a definite diagnosis and/or treatment. The diagnosis is based on signs, symptoms, and test of the animal itself.

In general, there are no records of the health status of family members available for diagnostic purposes. If available, these data might be of diagnostic excellence. Presently veterinarians are forced to treat each case as an individual case. All cases seem individuals dogs, but in fact are to some extent genetically similar entities. The clinical evidence of familial patterns in disease distributions in the human population steadily increases, indicating that genetic predispositions are quite common. If studied carefully, many disease distributions show, (1) some unexplainable accidental cases, and (2) a distinct overrepresentation in family groups. In the latter category genetic initiation/promotion is likely.

Each case, of course is a case, and therefore we must conclude that its specific exposures were "sufficient

cause" to introduce clinical illness. The exact combination of initiating and promoting factors will probably remain obscure of each case. Both initiating and promoting factors might be genetic or introduced by exposure in the living environment. The study of familial patterns in humans is hampered by the fact that genetic similarity within families in man often coincides with similarities in living environment.

Genetic- versus environmental exposures

The study of spontaneous cases in dogs might illuminate in possible influence of genetics factors. The advantages in dog populations might be (1) more genetically alike individuals per family group, (2) and after weaning a large variation in living environments.

Whereas family size and environmental exposures are advantages in study designs, the complexity of familial ties in purebred dog populations seems discouraging. Compared to the human population the variation in genetic ties is far less prominent. Each human can be considered to be highly related to a few close relatives and non-related to all other. In dogs, each dog is more or less related to all other animals within the breed. This fact ensures lesser genetic similarity between breeds than within breeds. Therefor breed is a genetic definition. Comparing breeds in their disease incidences/prevalences is valid to determine real (probably genetic) differences. However, this requires multiple breed studies in which similar clinical data and unbiassed population representations are present.

In fact genetic similarity within breeds might still vary between breeds, and between generations in a breed. We studied the possibility to use one-breed-studies, in which the variation in genetic similarity within a (generation of the) breed is compared its disease distributions. We designed (and tested) methodology to evaluate overall heterogeneity, and familial patterns in the studied generation, and tested the use of knowledge of population distributions as estimators for the individual's risk. If valid, investigators, vets and breeders could benefit from these estimators.

General population dynamics in dog breeds

The future population will be the overall result of (many) individual choices of breeders.

Regretfully, the overall choices by breeders do not ensure a stable (panmictic) development. Relatively few dogs which meet the standard best are used to produce the next generation. Preliminary analysis (unpublished) of the Dutch Kennel Club breeding records of purebred dog populations indicated that only 3 - 5% of all dogs registered in the Netherlands in the last 2 - 3 decades have contributed to the present populations. (Fig 1A) Thus, selection has led to a complex web of relatedness among breed members, caused by varying "exposures" to different founders. This process resembles the genetic bottle-neck. A bottle-neck that reoccurs more or less pronounced each generation.

Disease and bottle-necks

In this process genetic promoting/initiating factors might segregate to future generations, provided these were present in the "happy chosen few". In fact, veterinary reports indicate that nowadays most dog breed show their own breed-related diseases, often with a high incidence/ prevalences. Despite a distinct over representation, that forces investigators and breed clubs to advice and/or action, accurate knowledge of (1) the mode of inheritance or (2) the molecular basis of the factors is (might remain) unknown.

In the absence of accurate determination of a dogs 'genetic quality', breed clubs often regulate breeding

by 'phenotypic superiority' of their potential breeding stock. In itself this choice is reasonable, since the phenotypically superior dogs are averagely genetically superior as well. A steadily decline in incidence might be expected, provided that the genetic quality of the actual stock resembles an random sample of the genetic quality of all "phenotypically superior dogs". In practice however, de latter is not ensured. In fact the average genetic quality of the chosen 3-5% (bottle-neck) will determine the real future incidences. The average genetic quality of "the happy few" might still be better/equal/worse, compared to the mean quality of "phenotypically superior dogs" or even "all dogs". This explains the disappointing results of ±30 yrs of hip and breed clubs, a better insight in the genetic quality of individual is required, to recognise the dogs which despite a superior phenotype, are likely to have inferior genetic qualities. The inclusion of phenotypical data of family members can provide this insight. When longitudinal clinical data are available of the present generation, breeding value estimates or risk estimates, will prove to be superior to individual phenotypic criteria.

Familial patterns: cases overrepresented highly interrelated subgroups

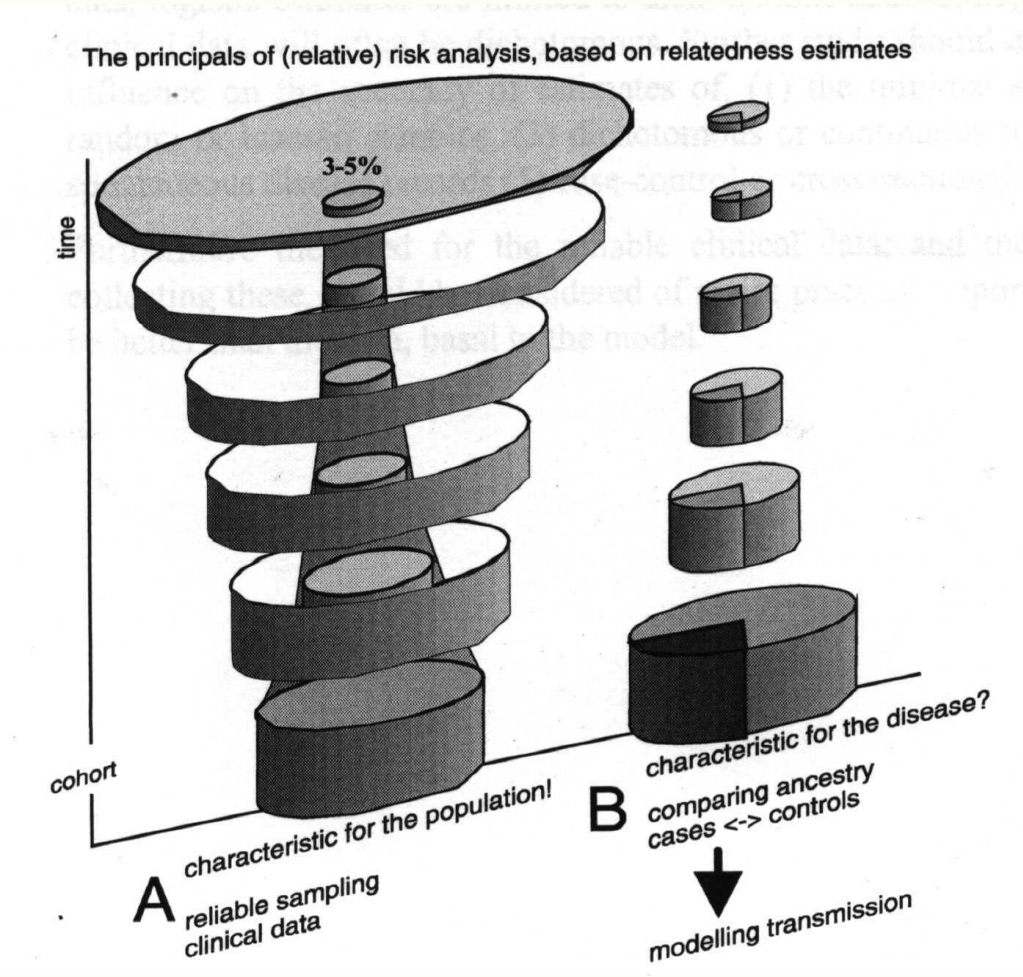
The genetic make-up of an individual dog may be considered the sum of contributions of its actual ancestors. The "genetic bottle-neck" ensures that some of these ancestors (range 0-20, median 5) are shared as sources of genetic similarity. Variation occurs in the sources (which ancestors?) and extent (how much per ancestor?).

Along the lines of a classic longitudinal cohortstudy, the extent of similarity is estimated between all combined dogs. A (hierarchical average-between) cluster analysis simplifies the enormous complexity of all detailed relatedness estimates into a easier to understand dendrogram with highly interrelated subgroups. All animals within a group (a cluster) are genetically more alike compared to the animals in each other group. This provides overall insight in the complete population.

The cohort can be described in (1) the number of clusters, (2) the variation in size between clusters, and (3) the average relatedness between clusters. Each of these parameters might be different and characteristic for the studied generation in a breed population. Subsequent labelling of the cases, will show if a familial pattern is apparent.

Individual risk estimates

Despite the insight in overall heterogeneity and familial patterns in a breed generations, advantageous to monitor overall breed development, breeders choices are still choices between individuals (matings). Within families (clusters) a increased similarity is obvious, but some variation in sources and extent of similarity still remains. Therefor an different approach is necessary for individual estimates.



Individual estimates are possible with cohort studies with the presence of disease as dependent factor and relatedness estimates with common ancestry as independent factors. All common ancestors are individually tested for their association with the disease labels in the cohort, by score tests. Risk estimation focusses on the most associated ancestors that are (more than averagely) associated with cases. Relatedness with all of the thus selected ancestors is then estimated for the cases and the controls.

A principal component analysis is then applied to the set of estimates. This intermediate statistical analysis, (1) provides continuous parameters, (2) limits the number of parameters and (3) limits the number of [0] is various cells. This ensures maximal informativeness, even when the clinical data sets are rather small. Sufficient principal components (cumulatively, at least 95% of existing variation in ties with the selected ancestry) in are finally fitted in a logistic regression model. This model describes the most likely pattern of passage of genetic risk factors over the generations by the weighed contributions of the most associated ancestors (Rothman 1986).

Conclusion

The permanent genetic bottle-neck by which the present dog populations have been formed provided an alternative approach to estimate the risk for selected combinations of dogs to produce offspring with inherited disease. Given the high degree of relatedness of dogs in a population and the availability of computerized pedigrees over many generations, held by the National Kennel Clubs, it is possible to compute risk factors if sufficient clinical data are available. These estimates could provide the veterinarians with valuable diagnostic tools suited for purebred patients, and breeders as counselling tool to limit the frequent re-occurrence of cases,

Questions, remaining for investigators

Both breeding-value and risk-estimates, can be applied to increase knowledge of the real genetic quality and/or clinical risk of a dog. These methods mainly vary in the use of statistical methods. Linear regression (modified BLUBs) versus logistic regression. In theory, the linear techniques can be applied to

both quantitative and dichotomous clinical data, logistic estimates are limited to dichotomous data. In dog breeds the best possible clinical data will often be dichotomous. Further study should increase knowledge of the influence on the accuracy of estimates of, (1) the minimal sample size required, (2) random or biassed samples, (3) dichotomous or continuous test results, (4) the use of spontaneous disease records (5) case-control or cross-sectional designs.

Furthermore the need for the reliable clinical data, and the most practical way of collecting these, should be considered of major practical importance. A model can never be better than the data, basal to the model.

CONTROL OF ELBOW DYSPLASIA IN SWEDEN BY AN OPEN REGISTRY

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Because Sweden has a well controlled and registered population of dogs and good co-operation between the veterinary profession, the Swedish Kennel Club and the breeders we have been able to institute extensive screening programs to control i.e. hip dysplasia (HD), elbow dysplasia(ED) and hereditary eye defects.

Common features of these programs are:

1 Fairly extensive screening involving not only breeding stock.

I Registration of all results (negative as well as positive), linked to the ancestral background of each individual.

II Open information on all results (negative as well as positive)

III Counselling to breed clubs on design and development of individual screening and control programs.

IV Feed back to breed clubs and breeders on prevalence of each condition as correlated with year of birth and status of breeding stock.

This design has made it possible to use not only individual status but also family records (including progeny results, when available) to indicate superior breeding stock with reference to polygenic traits like HD and ED. Education, information and computerised service to the breeders have resulted in significantly improved breeding stock with reference to polygenic traits as HD and ED. Decreased prevalence of these conditions as related to increased use of superior breeding stock have been monitored by statistics derived from the entire Swedish population of each breed.

Cost- benefit analyses of control programs for HD and ED have not only demonstrated a significant decrease in prevalence over time, but also proved in financial terms, that co-operative investments in screening and registration quite soon pays off to such an extent that just the value of dogs "saved" from severe grades of these diseases exceeds the cost involved

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POSSIBILITIRES FOR GENETIC CONTROL OF ELBOW DYSPLASIA BY DNA SCREENING

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Molecular-genetic analysis of inherited canine disorders has been hampered in the past by the lack of an adequate genetic map. In the last two years we have seen a dramatic change in that an extensive map of more than 700 markers has become available. This will allow for the determination of the chromosomal location of major genes for traits and diseases. Now that the sequencing of the human genome is largely completed, comparative human-dog chromosomal maps and a canine Bacterial Artificial Chromosome Library are available, there is a great window of opportunity to integrate molecular genetics in the control of inherited diseases in dogs.

An accurate description of the phenotype is the corner stone for any molecular-genetic investigation. We have chosen to study a cohort of Labrador dogs bred and owned by the Royal Dutch Guide Dog Association. In this subpopulation FCP is the predominant form of elbow dysplasia. Only animals free of any clinical or radiological sign of elbow dysplasia were used for breeding. All littermates were screened at the age of 12-18 months of age for elbow dysplasia according to a standard protocol by the same clinician.

Eighteen litters consisting of 88 males and 65 female dogs in which at least one affected dog was diagnosed were studied. Thirty male dogs were affected while only 9 female dogs were affected. Taking into account the total number of affected dogs and the striking predisposition for FCP of the male dogs it is concluded that the inheritance of the disease might by autosomal dominant with reduced penetrance in female dogs. This conclusion can be of practical use in that besides radiological screening of both prospective parents, the family history of the female dogs should be given particular attention.

Further progress of the understanding of the inheritance of FCP can only come from DNA studies for which the collected family material is particularly suited. We are performing the DNA studies as follows:

First, for candidate genes which are known to be expressed during development of cartilage and bone closely linked DNA markers are identified in the existing map or are isolated from the corresponding Bacterial Artificial Chromosomes. The allele distribution of the markers in affected dogs is compared with that of unaffected dogs. If there is any hint of a difference in allele distribution the association study is followed by a formal genetic linkage analysis. This approach is of course hampered by the lack of a similar phenotype in either the human or mouse. Therefore also a genome scan is performed. DNA markers distributed as equally as possible over all canine chromosomes are tested in the same way on DNA pools of affected and unaffected dogs. As yet we have not been able to assign a particular chromosomal region to the occurrence of FCP. On the other hand this means that we have excluded about 80 % of the canine genome to be involved. To make further progress a much denser genetic map is clearly needed.

EARLY RADIOGRAPHIC DIAGNOSIS OF ELBOW DISEASE AND ITS PREDICTABILITY IN A COLONY OF LABRADORS

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Introductie: In contrast to the Bernese Mountain Dog, recent studies in our colony of Labrador Retrievers indicated that the major proportion of dogs with a primary lesion in the elbow joint already showed signs of osteoarthritis at the average age of 12 months. The purpose of the present study was therefore to determine the radiographic predictability of elbow disease (ED) at the average age of 8 months.

Material and methods: Between October 1997 and June 1999, 119 Labrador Retrievers of the Swiss Breeding Kennel for Guide Dogs for the Blind were radiographically examined for ED two times: at the approximate age of 8 and 12 months. Neutral mediolateral (85 - 120^0) and craniocaudal projections (15^0 pronation) of the elbow joints were obtained. Radiographs were evaluated for primary and secondary lesions according to the ED - protocol by Lang et al.[1] ED was defined according to the 1999 protocol of the International Elbow Working Group in Orlando.

Results: The mean age at examination was 236 and 390 days. The overall prevalence of ED was 16.8% (95% CI: 10.5 - 23.1) and 26.9% (95% CI: 18.9 - 34.9), respectively. There was moderate agreement between the first and second radiographic examination (kappa=0.45). With reference to the second examination sensitivity and specificity of the first observation were 0.48 and 0.93. Positive and negative predictive values were calculated as 0.75 and 0.83, respectively.

Conclusions: Early radiographic examination for ED at the mean age of 236 days did not prove a sufficiently reliable method for prediction of ED in a colony of Labrador Retrievers.

Reference:

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POSTNATAL DEVELOPMENT OF THE ELBOW OF RETRIEVERS,

WITH EMPHASIS ON THE MEDIAL CORONOID PROCESS OF THE ULNA

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Introduction. One of the most frequently occurring developmental disorders in the elbow joint of Labrador retrievers in the Netherlands is the fragmented medial coronoid process. Several studies have been carried out to investigate the cause of the fracture, a number of hypotheses have been proposed and a genetic predisposition was demonstrated. The aim of the present study was to assess in retrievers the normal morphogenesis of the elbow and the medial coronoid process in particular, in order to provide qualitative and quantitative data to evaluate the existing hypotheses about the cause of the fracture.

Materials and methods. The left elbows of ten golden retrievers, aged 4, 6, 8, 10, 13, 16, 18, 20, 22, and 24 weeks were investigated. After euthanasia the animals were perfused with saline and buffered formaldehyde 4%. The elbow, in a slightly flexed position, and the surrounding tissues were removed en bloc and immersed for 3 weeks in formaldehyde solution. The bloc was then frozen and serially sectioned on a large heavy-duty cryomicrotome. The bloc was photographed after every 5 sections and the pictures were digitized at a resolution of 1528*1146. The pictures were printed in coronal, transversal, and lateral view. Three-dimensional reconstructions of the pictures were made with special software. After every tenth photograph a 26 microns cryosection was collected on cellotape and stained with a modified Mallory-Cason staining procedure. The sections on cellotape were also photographed and printed in the sectioning view. In the near future these photographs will also be reconstructed in 3D as well.

Discussion. This method provides the 3D morphology of bones, articular surfaces, ossification zones, and distribution of bone and cartilage. By the use of dogs aged 4 weeks up until 24 weeks the growth and development of the elbow in time can visualized. In the reconstructions additional data can be added like trabecular patterns, histological data, and enzyme activities. In this poster preliminary data are presented. The aim of the poster is to present the working technique, showing a different way of looking at the elbow.

INVESTIGATION ON UNUNITED ANCONEAL PROCESS IN THE ELBOW JOINTS IN 52 GERMAN SHEPHERD DOGS

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Introduction: In this study, it was aimed to investigate incidences of ununited anconeal process in German Shepherd Dogs. Ununited anconeal process is a disease affecting large breeds of dogs particularly the German Shepherd and is caused lameness and osteoarthritis of elbow joint because of anconeal process and ulna are not found.

Material and Method: The study was carried out on total 52 German Shepherd dogs in a dog military breeder. The radiological positions used are the hyperflexed medio-lateral and anterio-posterior .

Results: Consequently, a total 6 cases of ununited anconeal process (4 bilateral, 2 unilateral) were determined in 52 animals. In one of the 6 cases fragmented medial coronoid process was seen in association with ununited anconeal process. The incidence found was 11.54%.

VALUE OF RADIOGRAPHIC SCREENING OF LARGE JOINTS IN DOGS AFFECTED BY ELBOW DYSPLASIA: END RESULTS (58 CASES).

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Purpose of this prospective study: Some pure-breed dogs can have multiple developmental (gene-related or not) joint disorders. ED is one of the most common orthopaedic disorders primarily affecting young dogs belonging to large or giant breeds. The same breeds are at high risk for developing several orthopaedic diseases. Among these HD, OC and/or OCD, metatarsal rotation and eventually sesamoid bone diseases are of major concern. Consequently the association between ED and one or more of the previously mentioned conditions is to be expected.

The aim of this study was to investigate by survey radiography main appendicular joints in fast-growing dogs clinically affected by elbow dysplasia to detect additional symptomatic or asymptomatic concurrent developmental joint conditions in order to decide for appropriate treatment and to formulate an accurate prognosis.

Materials & methods: A radiographic study was performed on young large and giant breed dogs with non traumatic front leg lameness referred to our department from April 1997 since July 1999. Clinical examination localized the source of lameness to the elbow in 78 dogs out of 312. Preliminary examination of these joints was consistent with ED in 68 dogs. 10 dogs were excluded because older than 18 months. Fifty-eight dogs were then included in this study. Signalment and history were taken and the animal's general health was assessed before orthopedic examination. Patients were first observed walking, trotting, galloping and climbing stairs outside and evaluated for muscle atrophy, abnormal muscle development, short stride and limb deformity. Joints were evaluated when the animal was standing for effusion and periarticular soft-tissue swelling. Joints were also examined for crepitation during flexion and extention and palpation was performed including an evaluation of range of motion during hyperflection and hyperextension.

Lameness of one forelimb was usually evident but decreased ability to flex or extend the elbow, thickening, pain on manipulation and/or crepitation were considered for inclusion when lameness was not present at the moment of the examination. A complete orthopedic examination was performed considering all appendicular bones and joints also of the rear limb to detect other orthopedic disorders and to rule-out additional neurologic abnormalities. Owners were asked to participate the study with no charge.

Survey radiography included the following projections: SHOULDER: ML view. ELBOW: four views of both elbow joints were taken: ML-standard 110 , ML hyperflexed, anteroposterior and anteroposterior 30 medial oblique. HIP: standard ventro-dorsal (lateral, distraction view, frog and D.A.R. when indicated). STIFLE and HOCK: AP views. HAND and FOOT: dorso-palmar and dorso-plantar views only in rottweilers. Carpal joint was not considered due to the scarcity of developmental abnormalities on this joint. Additional projections were taken when abnormal radiographic findings were detected by previous views. A minimum of 15 radiographs to a maximum of 20 were taken per each dog. Radiological investigation of the elbow was performed according to a standardized protocol, based on the guidelines of the International Elbow Working Group.

Results: Fifty-eight dogs were included in this study. Signalment and radiographic findings are summarized in table 1. In 14 out of 58 the source of front-leg lameness was attributed also to other conditions (7 shoulder OCD, 4 sesamoid bone diseases and 3 radius and/or ulna enostosis) and in 7 dogs a hind-leg lameness was simultaneously detected related to HD, 2 related to hock OCD and 1 related to tibia enostosis.

Twenty Rottweilers, 7 Newfoundlands, 11 German shepherds, 4 Golden Retriever, 2 Labrador Retrievers, 4 Dogue de Bordeaux, 3 Mastino Napoletano, 2 Corso Dog, 2 Bernese Montain Dog 1 Saint Bernard, 1 Great Dane and 1 Bull Mastiff were represented. The mean age was 9,3 months ranging from 6 to 18; 49 on 58 (84%) were males and 9 on 58 (16%) were females.

Fifty-eight out of 58 (100%) had radiographic evidence of elbow dysplasia at least on one elbow. In 45 out of 58 (76%) both elbows were radiographically involved. On 112 elbows, 12 (10,7%) were graded as normal, 25 (22,4%) were classified as ED of first degree, 23 (20,5%) of second, 52 (46,4%) of third.

Thirty-eight (34%) FMCP and 9 (8%) UAP were identified or suspected. In one case both FMCP and UAP were diagnosed in the same elbow.

Fifty-three out of 58 dogs (91%) were diagnosed to have other developmental joint disorders in addition to ED. Fifty-four out of 58 (93%) had elbow dysplasia and hip dysplasia.

Twelve Rottweilers out of 20 (60%) had additional joint disorders besides ED and HD: 1 shoulder OCD, 3 metatarsal rotation, 4 sesamoid bone diseases, 2 metatarsal rotation in addition to sesamoid bone diseases and 2 hock OCD

These conditions were simultaneously detected while clinically symptomatic or not.

Discussion While the simultaneous presence of ED and other front-legs joint disorders, *clinically and radiographically detected*, should be confounding for the finally diagnosis of lameness, (elbow vs other joints - elbow plus other joints) *the radiographic detection* of concurrent front-limbs and or hind-leg disorders *clinically asymptomatic* should not be underestimated. Their clinical manifestation could become actually evident later in time. All the more so when the health leg is overloading because of another limb disorder (pain and/or post-operative limb immobilization) caused by ED. Finally careful attention deserves the patient having ED in addition to *symptomatic hind-leg orthopaedic disorder/s* both for therapeutical and prognostic evaluation (e.g. HD).

Owners and breeders sometimes reject the clinician advice of excluding their dogs from reproduction even if affected by ED. The coexistence in a particular dog of negative traits like ED and positive morphological or behavioural characteristics represents the major deterrent towards this breeding program policy.

Radiographic detection, in addition to ED, in such a dog, of one or more joint developmental disorders, symptomatic or not, potentially inheritable, should convince even the more reluctant owner not to use his dog for reproductive purposes. In conclusion, from a practical point of view, the results of this study do not support the absolute necessity of an expensive and time consuming overall radiographic screening in

elbow dysplasic dogs. However, the value of this radiographic screening, from a scientific point of view, although speculative, is less questionable. Finally in Rottweiler dogs, a true orthopaedic "puzzle", such a screening is strongly recommended for the possible prognostic implications.

Conclusion Adequate clinical and radiographic investigation of distal extremities in addition to hip and elbow joints seems to be mandatory in Rottweilers to detect sesamoid bone disorders and/or metatarsal rotation, hock and malleolar tibial OC/OCD in order to decide for treatment designed to relieve or cure the disability/ies and to formulate an accurate prognosis.

Preliminary results of this work were presented at the 1998 IEWG meeting (Bologna)

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