

The influence of breed standard related disorders and inheritable diseases in pedigree dogs on differential diagnoses and the diagnostic process.



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The influence of breed standard related disorders and inheritable diseases in pedigree dogs on differential diagnoses and the diagnostic process.

Glossary of terms

- *UKG*: "UniversiteitsKliniek voor Gezelschapsdieren", University Clinic for Companion animals.
- *Inheritable breed-related disorder*: conformation-related disorder and/or inherited disorder specific for a certain breed.
- *Conformation-related disorder*: disorder related to breed standard.
- *Inherited disorder/disease*: genetic disorder not related to breed standard.

1. Abstract

In first opinion veterinary practice differential diagnoses play an important role in the diagnostic process. Many differential diagnoses exist for the different animal species and breeds treated by a veterinarian. In dogs, a special situation might be of importance. Influenced by the manners of (in)breeding, mainly based on selection of breed characteristics, inheritable disorders might appear in a much higher frequency in pedigree dogs compared to crossbreeds. In this study general differential diagnoses per organ system are set up based on the VeNom Codes, literature search and interviews with specialists of the University Clinic for Companion animals (UKG). These general lists of differential diagnoses per organ system are compared to data collected from databases of first and secondary care clinics for the Chihuahua, Labrador, French Bulldog and crossbreeds. Analysis of these data shows that breed is influential on the differential diagnosis and the diagnostic process in first opinion practice.

2. Introduction

In the Netherlands over 2.800 veterinarians are employed in companion animal practice, working in at least 1.000 practices all over the country (KNMvD). The majority of these practices are first line practices, where primary care is offered to the broad scala of animal species kept as companion animal. In first line practice, specialized equipment is often limited and complex patients can be referred to specialized, secondary care clinics.

Aforesaid first opinion veterinarians experience busy days, where an average of 20 patients a day is not uncommon. Patients with a variety of problems visit the practice, for which the veterinarian has to try and find a solution within 10-20 minutes. The combination of extent of the range of patients, the time constraints and financial limitations often make it impossible for a first opinion veterinarian to do all the diagnostic testing he/she would like to perform, to confirm the diagnosis. Therefore, working with a list of differential diagnosis is general practice and a useful tool.

The veterinarian performs the anamnesis and clinical research to determine which problems the patient has and which organ system is affected. Based on the results, a differential diagnosis is considered, containing a list of possible diagnoses for the patient at hand. Using the information given by the owner combined with the patients' symptoms, prioritizing can take place within the list. However, frequently a number of diagnoses remain highly likely. An additional support for the choice of further investigation and the decision to which therapy will be applied, is prioritizing based on the incidence of a disorder. Common disorders are ranked higher on the list of differential diagnoses than rare ones. However, exact numbers concerning the frequency of incidents most likely are non-existent, bringing the veterinarian to a diagnosis mainly based on his personal experience.

Separate lists of differential diagnoses exist for dog and cat, because these animals show different disorders and the incidence of similar disorders differ per animal species. For example, elbow dysplasia is often seen in dogs (Kirberger et al, 1998), whilst this disorder is very rare in cats. Besides, it is known that the dog is the most diverse animal species in the world, over 400 breeds are known, variable from 0.5-95 kg (Arman, 2007). In purebred dogs more than 500 inherited diseases exist, some of which are only described in a few, or even a single, breeds (Arman, 2007). Keeping this in mind, the hypothesis is set up that in pedigree dogs breed influences the differential diagnosis and the diagnostic proces in first opinion practice.

Historically dogs were used as an utility animal, for example as a watchdog or for herding of cattle. Today, dogs are still used as guard or herding dogs, but the vast majority are a companion animals. The latter must meet various requirements of humans, in character and appearance. The pursuit of an ideal

appearance has had much influence on the high frequency of inheritable breed related disorders that can be found in many pedigree dogs. The first dog shows were held in the 19th century and specific breeds and breed standards were established. In order to comply with these standards and create breed purity, specific breeding practices were used, such as the overuse of popular sires and/or mating between related dogs. Besides, the number of individuals used as founding stock, which is small in many breeds, and how closely related they are, has an influence on the genetic health of a breed (Leroy et al, 2011).

These breeding practices have led to inheritable breed-related disorders, such as conformation related disorders, a direct consequence of breed standards, and inherited diseases. One of the reasons for the abnormally high occurrence of inherited diseases, is genotypic homozygosity. Heterozygosity is an important occurrence for species' survival and fortitude, but many desired breed traits are recessive and require that both copies of the inherited allele be the same for the trait to be expressed phenotypically (Arman, 2007). When breeders select for desired traits, they also select for other genes that are specifically linked to these 'good genes'. When alleles do not assort independently, the doubling up of both good and bad genes occurs. So, when breeders select for preferred traits, they may also select for deleterious genes that can result in diseases. All individuals carry deleterious genes, but because these deleterious genes are ordinarily recessive and usually inherited in a heterozygous way, there is no harmful impact on health (Arman, 2007). The resultant purebreds possess homozygous genes for the existence of over 500 inherited diseases (Arman, 2007).

Besides these genetic defects, which can result in inherited diseases, the desired trait is often harmful in itself. If such a conformational trait causes health problems, it is called a conformation related disorder. Since these features are set in the breed standard, this can be considered a conscious choice of breeders and consumers. An example of a harmful breed characteristic is the brachycephalic obstructive syndrome, seen in, amongst others, the French Bulldog. Since having a short brachycephalic skull is an important characteristic of the breed, the proportions of the upper respiratory system have changed and many animals of this breed suffer from breathing problems (Arman, 2007; Asher et al, 2009).

An increasing number of studies have been conducted about inheritable breed related disorders (Ubbink et al., 2000; Mäki et al., 2001; Urfer, 2009; Wellmann and Pfeiffer, 2009; van der Beek et al., 1999; Lewis et al., 2010). However, the incidence and impact of diseases in pedigree breed's populations in the Netherlands are unknown. Therefore the "The Expertise Centre Genetics for Companion Animals of Utrecht University" has started a wide scaled investigation called "*Incidental breed related inheritable disorders and harmful breed characteristics in Dutch populations of small animals*". This project aims to establish the incidence of breed standard related disorders and inheritable diseases in populations of pedigree dogs and cats, by implementing a national veterinary disease monitoring database, which will help policy makers to develop health programs for Dutch pedigree breeds. The results of this pilot study will be

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the basis for this research, in which the hypothesis was tested that breed standard related disorders and inherited diseases in a pedigree population will influence the priority in differential diagnosis and the diagnostic process.

3. Materials and methods

3.1 Differential diagnoses per organsystem

In order to assess the influence of breed standard related disorders and inheritable diseases in pedigree dogs on priority in the differential diagnoses per breed and the diagnostic process, randomly organized differential diagnoses were compared to differential diagnoses per breed in the selected organs. To start with, randomly organized differential diagnoses were set up - in a stepwise approach. First, organs were classified according to anatomy, mainly based on the ATCvet system (www.whocc.no/atcvet), as well with reference to published literature (Nelson et al, 2009; Ettinger et al, 2009). Second, non-infectious diseases documented by the VeNomCoding Group were assigned to the organs. The VeNomCoding Group has developed a standard set of clinical veterinary terms (VeNom Codes), for use in first opinion veterinary practice management systems and referral veterinary hospital electronic patient records (www.venomcoding.org). Third, an additional literature search was performed. A wide variety of scientific literature was used, the most important source being veterinary textbooks (Nelson et al, 2009; Ettinger et al, 2009). All disorders named in the VenomCodes and veterinary textbooks per organ system, were listed. Using this comprehensive list of disorders, a systematic search of scientific and veterinary literature was conducted, to check the importance for first opinion veterinary practice, and/or the incidence in the country where this research was carried out (The Netherlands). Online bibliographic databases were used, such as PubMed and Google Scholar, employing each of the following search criteria:

[Disease name] AND [DOG OR CANINE]

[Disease name] AND [DOG OR CANINE] AND [HOLLAND OR NETHERLANDS]

Each organ system was linked to a certain discipline of the UKG, where board certified specialists per discipline were requested to verify the lists.

By these four steps, accessible lists of general differential diagnoses were generated, containing all non-infectious disorders important in first opinion practice.

3.2 Pilot study first line practice

A pilot study has been performed to measure incidences of breed related disorders in four breeds – Chihuahua, French Bulldog, Labrador Retriever and Persian cat (Meijndert, 2014). The cumulative incidence of disease in selected organs was calculated from manually collected data of ten first line veterinary clinics. The organ systems were selected by literature search per breed, interviews with board certified specialists on relevance of diseases for the Dutch populations and database analysis at the UKG. The obtained incidences in the

first line veterinary clinics, were compared to incidences in a control group of crossbreed dogs or regular housecats, selected similarly from the ten practices.

Per breed the organ systems in which disease frequency was significantly higher than the control group were selected. These organ systems have been used in this study for the comparison of differential diagnosis.

3.3 UKG database analysis

The results of the pilot study (Meijndert, 2014) revealed in which organs disease frequency was higher in Chihuahua, French Bulldog, Labrador Retriever compared to the control group of crossbreeds. A database analysis at the UKG was carried out to indicate the breed specific disorders in the selected organs. To perform this analysis, the selected organ systems were matched to the corresponding disciplines within the UKG. Several parameters were investigated per breed, such as:

- Total number of Chihuahua, French Bulldog, Labrador Retriever and crossbreed consultations at the UKG per selected discipline
- Per selected discipline: which disorders were diagnosed in Chihuahua, French Bulldog, Labrador Retriever and crossbreeds

The following parameters were investigated for each individual dog:

- Patient number
- Consult date
- Breed
- Date of birth
- Consulted discipline
- Diagnosis

In order to include a sample size large enough for statistical evidence, data collected over a time span of five years were analyzed. The period 2009-2013 was used, since this is the most current information available. The crossbreed consultations formed the control group in this study, containing all dogs signed up with 'no breed' or 'crossbreed'. Dogs joining a screening program of a Kennel Club or breed association, were excluded from this analysis.

For each breed the three most diagnosed diseases per selected discipline were used for the statistical analysis.

3.4 Statistical analysis

Per breed the three most diagnosed diseases per discipline were used for the statistical analysis. A Fisher's Exact test was used to evaluate the significant difference ($P < 0,05$) between the number of pedigree dogs (Chihuahua, French Bulldog and Labrador Retriever) and the number of crossbreeds, diagnosed a certain disease per discipline at the UKG. When significant differences were detected, the mean age of occurrence was calculated for disease in pedigree dogs and crossbreeds, together with the median, minimum and maximum age of occurrence. A median test was computed to test the statistical difference in median age of occurrence. All results were compiled and analyzed with SPSS version 20.

3.5 New ranking

If a statistically significant difference was evaluated, the disease is proved to occur more often in the selected breed compared to crossbreeds. This difference in incidence influences the differential diagnosis, statistically significant over-represented diseases are more likely to occur and thus placed higher in ranking.

4. Results

4.1 Differential diagnoses per organ system

The classification of organs (based on the ATCvet system) is shown in figure 1.

Fig. 1: Organ classification (<http://www.whocc.no/atcvet>)

<u>Organ classification</u>
Alimentary tract
Mouth and throat
Gastrointestinal tract
Liver, biliary system and vena porta
Exocrine pancreas
Blood and blood forming organs
Cardiovascular system
Dermatological disorders
Urogenital system
Reproductive organs and mammary glands
Kidneys
Bladder and Urinary tract
Systemic hormonal changes (excl. sex hormones and insulin)
Pituitary, hypothalamus and adrenals
Parathyroid gland
Thyroid gland
Endocrine pancreas
Neoplastic disorders
Musculo-skeletal system
Hip joint
Elbow joint
Stifle joint
Remaining joints
Vertebral column
Nervous system
Brain
Spinal cord – cervical
Spinal cord – thoracolumbal
Spinal cord – lumbosacral
Peripheral nerves
Respiratory system
Upper airway
Lower respiratory tract
Eyes
Ears

Differential diagnoses of organs of importance are shown in fig. 2 (Musculo-skeletal system), fig. 3 (Reproductive organs and mammary glands), fig.4 (Eyes), fig. 5 (Ears), fig. 6 (Respiratory system) and fig. 7 (Vertebral column). The differential diagnoses of the remaining organs shown in fig. 1, are attached in Annex 1.

Fig. 2: Differential diagnosis Musculo-skeletal system

Musculo-skeletal system

Hip joint

- Hip dysplasia
- Avascular necrosis head of femur (Calvé-Legg-Perthes)
- Osteoarthritis/-arthritis
- Hip luxation
- Fracture
- Neoplasm

Elbow joint

- Elbow dysplasia
 - Ununited anconeal process (UAP)
 - Fragmented coronoid process (FCP)
 - Osteochondrosis dissecans (OCD)
 - Elbow incongruity (EI)
 - Medial compartment syndrome (MCD)
- Osteoarthritis/-arthritis
- Elbow luxation
- Fracture
- Neoplasm

Stifle joint

- Patellar luxation
 - Medial
 - Lateral
- Patella alta
- Patella baja
- Cruciate ligament disorder
 - Cranial cruciate ligament (CCL) injury
 - Caudal cruciate ligament injury
- Meniscal injury
- Osteoarthritis/-arthritis
- Fabelar fracture/absence
- Fracture

Remaining joints

- Osteoarthrosis/-arthritis
 - Ankylosis
- Osteochondrosis (dissecans)
- Trauma
 - Fracture (intra-articular)
 - Contusion
 - Distorsion
 - Luxation
 - Arthritis (traumatic)
- Polyarthritis
- Polyarthropathy
- Neoplasm

Vertebral column

- Discospondylitis
- Spondylosis
- Hemivertebra
- Too many vertebrae
- Too little vertebrae
- Scoliosis
- Diffuse idiopathic skeletal hyperostosis (DISH)
- Dens aplasia
- Trauma
 - Fracture
 - Contusie
 - Distorsion
 - Luxation
- Neoplasm

Unspecified

Bone

- Fracture
- Inflammation
 - Panosteitis
 - Osteomyelitis
- Deformities
 - Varus
 - Valgus
 - Chondrodysplasia
 - Chondrodystrophy
 - Aplasia
- Bone diseases
 - Osteopetrosis
 - Osteomalacia
 - Osteofibrosis
 - Chondrodysplasia
 - Hypertrophic osteodystrophy (HOD)
 - Neoplasm

Muscles and tendons

- Tendon rupture
- Muscle contusion
- Muscle contraction
- Muscle fibrosis
- Muscle rupture
- Myositis
 - Generalised
 - Masticatory muscle myositis
- Tendinitis
- Tendovaginitis
- Tendon luxation
- Neoplasm

Jaw

- Malocclusion
 - Underbite
 - Overbite
- Jaw luxation
- Luxation mandibular coronoidal process
- Trigeminal paralysis
- Craniomandibular osteopathy
- Inflammation
- Fracture
- Neoplasm

Foot

- Phalanx luxation
- Polydactyly
- Split hand
- Anomalia
- Inflammation
- Fracture
- Neoplasm

Fig. 3: Differential diagnosis Reproductive organs and mammary glands

- Reproductive organs and mammary glands**
- Female reproductive abnormalities**
- Ovarian disorder
 - Ovarian cyst
 - Neoplasm
 - Uterus, cervix
 - Endometrial cystic hyperplasia
 - Mucometra
 - Endometritis post partum/acute puerperal endometritis
 - Endometritis post oestrus, cervix opened
 - Endometritis post oestrus, cervix closed (pyometra)
 - Subinvolution of placental sites (SIPS)
 - Inversio et prolapsus uteri
 - Neoplasm
 - Vagina, vestibulum, vulva
 - Vaginitis
 - Juvenile vaginitis
 - Adult bitch
 - Castrated
 - Non-castrated
 - Vaginal fold hyperplasia
 - Vaginal septum
 - Neoplasm
 - Mammary glands
 - Neoplasm
 - Mastitis
 - Pseudopregnancy
 - Pregnancy/parturition
 - Resorption
 - Abortus
 - Torsio uteri
 - Dystocia
 - Primary uterine inertia
 - Fetalpelvic disproportion
 - Fetal maldisposition
 - Monstrum
 - Cycle
 - Persisting anoestrus
 - Primary (not been in oestrus before)
 - Secondary (in oestrus before)
 - Persisting (pro-)oestrus
 - Granulosa cell tumor
 - Ovarian cyst
 - Pseudopregnancy
 - Non-ovulating oestrus
 - Split heat

Male reproductive abnormalities

- Testis en scrotum
 - Infertility
 - Cryptorchidism
 - Delayed testicular descensus (> 9 weeks post partum)
 - Orchitis(/epididymitis)
 - Scrotitis
 - Hernia inguinalis/scrotalis
 - Torsio testicularis
 - Trauma
 - Testicular neoplasm

- Prostate
 - Benign prostatic hyperplasia
 - Prostatitis
 - Prostatic abcess
 - Prostatic cyst
 - Neoplasm

- Penis en preputium
 - Balanoposthitis
 - Phimosis
 - Paraphimosis
 - Priapism
 - Persisting frenulum preputiale
 - Fracture os penis
 - Trauma
 - Neoplasm

Miscellaneous

- Abnormal reproductive development

Fig. 4: Differential diagnosis Eyes

Eyes

- Orbita
 - Retrobulbar process
 - Trauma
- Lacrimal apparatus
 - Keratoconjunctivitis sicca
 - Closure lacrimal punctum

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- Eyelids
 - Cherry eye
 - Inflammation
 - Blepharitis
 - Meibomian cyst
 - Melbominitis
 - Congenital
 - Entropion
 - Ectropion
 - Distichiasis
 - Ectopic cilia
 - Trichiasis
 - Coloboma
 - Trauma
 - Neoplasm
- Conjunctiva
 - Conjunctivitis
- Globe
 - Glaucoma
 - Primary
 - Secondary
 - Trauma
 - Luxatio bulbi
 - Hyphaema
 - Congenital
 - Microphthalmia
- Cornea and sclera
 - Lacerations
 - Superficial keratitis
 - Keratitis with ulceration
 - Keratitis pannosa
 - Corneal dystrophy
- Uvea
 - Uveitis
 - Anterior
 - Posterior
 - Iris
 - Iritis
 - Iris cyst
 - Coloboma
 - Neoplasm
- Lens and vitreum
 - Cataract
 - Lensluxation
 - Coloboma
- Fundus and N. Opticus
 - Ablatio retinae
 - Neuritis N. Opticus
 - Progressive retina-atrophy (PRA)
 - Hereditary retinal dysfunction

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Fig. 5: Differential diagnosis Ears

- Ears**
- Pinna
 - Othematoma
 - Inflammation
 - Neoplasm
- Otitis externa
 - Proliferative
 - Neoplasm
 - Idiopathic inflammatory/hyperplastic dermatitis
 - Chronic otitis externa
 - Ulcerative
 - Corpus alienum
 - Ceruminosa
 - Hypersensitivity/allergic otitis
 - Parasitary
 - Endocrine disorder
 - Cushing's disease
 - Keratinisation
 - Hypothyroidism
 - Hyperadrenocorticism
 - Sebaceous adenitis
 - Idiopathic seborroe
 - Auto-immune disorder
 - Pemphigus
 - SLE (systemic lupus erythematosus)
 - IHA (immune-mediated haemolytic anaemia)
- Otitis media/interna
 - Idiopathic otitis media
 - Otitis externa
 - Cholesteatoma
 - Primary Secretory Otitis Media (PSOM)
 - Corpus alienum
 - Neoplasm
- Atresia ear canal
- Congenital deafness

Fig. 6: Differential diagnosis Respiratory system- Upper airway

- Respiratory system – Upper airway**
- Nose and sinusses**
- Rhinitis/sinusitis
 - Aspergillosis
 - Aspecific/allergic
 - Idiopathic
- Nasal planum
 - Stenotic nares
 - Stenotic nares (due to BOS)
- Oronasal fistel
- Choanae-atresie
- Corpus alienum
- Trauma
- Neoplasm

Pharynx, larynx and trachea

- Nasopharynx
 - Reverse sneezing
 - Corpus alienum
- Pharynx
 - Elongated soft palate (due to BOS)
 - Pharyngitis
 - Tonsillitis
 - Corpus alienum
 - Trauma
 - Neoplasm
- Larynx
 - Laryngitis
 - Laryngeal paralysis
 - Laryngeal collaps
 - Grade 1: eversion laryngeal sacculi (due to BOS)
 - Grade 2: loss strength and medial relocation of arytenoid (processus cuneiformus)
 - Grade 3: collaps of arytenoid (processus corniculatus)
 - Trauma
 - Neoplasm
 - Vocal cords
 - Miscellanious
- Trachea
 - Tracheal collaps
 - Hypoplastic trachea
 - Tracheitis
 - Corpus alienum
 - Trauma
 - Neoplasm

Fig. 7: Differential diagnosis Vertebral column

Vertebral column

- Discospondylitis
- Spondylosis
- Hernia nuclei pulposi
- Hemivertebra
- Too many vertebrae
- Too little vertebrae
- Scoliosis
- Diffuse idiopathic skeletal hyperostosis (DISH)
- Dens aplasia
- Trauma
 - Fracture
 - Contusion
 - Distorsion
 - Luxation
- Neoplasm

4.2 Results pilot study

The organsystems, in which disease frequency was significantly higher than the control group, included for the Chihuahua the musculo-skeletal system and reproduction, for the French Bulldog the eyes and ears, respiratory system, vertebral column and reproduction and for the Labrador Retriever the musculo-skeletal system (Meijndert, 2014) (table 1). The organ systems, used for the differential diagnoses, are linked to UKG disciplines. The matches are shown in table 1.

Table 1: organsystems and UKG-disciplines per breed

Breed	Organsystem	UKG discipline
Chihuahua	- Musculo-skeletal system - Reproductive organs and mammary glands	- Orthopedics - Reproduction
French Bulldog	- Eyes - Ears - Respiratoy system – upper airway - Vertebral colomn - Reproductive organs and mammary glands	- Ophthalmology - KNO - Ears - KNO - Upper airway - Orthopedics/ Neurology - Reproduction
Labrador Retriever	- Musculo-skeletal system	- Orthopedics

4.3 Results statistical analysis & new ranking

The total number of Chihuahua, French Bulldog, Labrador Retriever and crossbreed consultations at the UKG per selected discipline is shown in table 2. These numbers contain the consultations with a diagnosis documented, the actual numbers of consultations were much higher (written in brackets). The consultations with no diagnosis documented, were not taken into consideration in the statistical analysis. For the disciplines Ears, Upper airway and Vertebral column, no actual number of consults per subdiscipline was calculated, represented with (?) in table 2.

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Table 2: UKG-consultations per breed per discipline

Discipline	Chihuahua	French Bulldog	Labrador Retriever	Crossbreeds
Reproduction	1 (6)	2 (4)	n.a.	14 (35)
Orthopaedics	22 (38)	n.a.	137 (254)	136 (216)
Ophthalmology	n.a.	57 (70)	n.a.	180 (231)
KNO - Ears - Upper airway	n.a.	32 (46) 11 (?) 21 (?)	n.a.	50 (80) 22 (?) 38 (?)
Vertebral column - Orthopaedics - Neurology	n.a.	27 (?) 15 (?) 12 (?)	n.a.	31 (?) 20 (?) 11 (?)

n.a. = non applicable

Chihuahua

UKG database analysis of the discipline Reproduction resulted in too little information to perform statistical analysis, hence this discipline is left out of consideration. The results of the statistical analysis of the three most diagnosed diseases in the discipline Orthopaedics, are shown in table 2. Statistically significant values are marked with *, if $P < 0.05$.

Table 3: Chihuahua, results statistical analysis Orthopaedics

Orthopaedics	Chihuahua	Crossbreed	p-value (FE)
Patellar luxation	11	13	0,000*
Fracture	3	16	0,713
CCL (cranial cruciate ligament) injury	2	27	0,372
Total	22	136	

As shown in table 2, patellar luxation was statistically significant more diagnosed in Chihuahuas compared to crossbreeds. All cases in the Chihuahua were medially luxating patellas. The median age of occurrence in Chihuahuas 1,1 year, whilst for crossbreeds 2,6 year. This difference in median age of occurrence is not

statistically significant.

The fact that patellar luxation occurs statistically significant more often in Chihuahuas compared to crossbreeds, results in a higher ranking of patellar luxation in differential diagnosis for this breed. Chihuahuas with musculo-skeletal problems, will have a higher chance of suffering from patellar luxation and thus suffering from a stifle joint problem compared to other musculo-skeletal disorders. Stifle – and patellar luxation, are placed higher in ranking compared to the general differential diagnosis of musculo-skeletal system (fig. 7). The disorder concerned is highlighted in grey.

Fig. 8: Chihuahua-specific differential diagnosis musculo-skeletal system.

Chihuahua – musculo-skeletal system

Stifle joint

- Patellar luxation
 - Medial
 - Lateral
- Patella alta
- Patella baja
- Cruciate ligament disorder
 - Cranial cruciate ligament (CCL) injury
 - Caudal cruciate ligament injury
- Meniscal injury
- Osteoarthritis/-arthritis
- Fabelar fracture/absence
- Fracture

Hip joint

- Hip dysplasia
- Avascular necrosis head of femur (Calvé-Legg-Perthes)
- Osteoarthritis/-arthritis
- Hip luxation
- Fracture
- Neoplasm

Elbow joint

- Elbow dysplasia
 - Ununited anconeal process (UAP)
 - Fragmented coronoid process (FCP)
 - Osteochondrosis dissecans (OCD)
 - Elbow incongruity (EI)
 - Medial compartment syndrome (MCD)
- Osteoarthritis/-arthritis
- Elbow luxation
- Fracture
- Neoplasm

Remaining joints

- Osteoarthritis/-arthritis
 - Ankylosis
- Osteochondrosis (dissecans)
- Trauma
 - Fracture (intra-articular)
 - Contusion
 - Distorsion
 - Luxation
 - Arthritis (traumatic)
- Polyarthritis
- Polyarthropathy
- Neoplasm

Vertebral column

- Discospondylitis
- Spondylosis
- Hemivertebra
- Too many vertebrae
- Too little vertebrae
- Scoliosis
- Diffuse idiopathic skeletal hyperostosis (DISH)
- Dens aplasia
- Trauma
 - Fracture
 - Contusie
 - Distorsion
 - Luxation
- Neoplasm

Unspecified

Bone

- Fracture
- Inflammation
 - Panosteitis
 - Osteomyelitis
- Deformities
 - Varus
 - Valgus
 - Chondrodysplasia
 - Chondrodystrophy
 - Aplasia
- Bone diseases
 - Osteopetrosis
 - Osteomalacia
 - Osteofibrosis
 - Chondrodysplasia
 - Hypertrophic osteodystrophy (HOD)
 - Neoplasm

Muscles and tendons

- Tendon rupture
- Muscle contusion
- Muscle contraction
- Muscle fibrosis
- Muscle rupture
- Myositis
 - Generalised
 - Masticatory muscle myositis
- Tendinitis
- Tendovaginitis
- Tendon luxation
- Neoplasm

Jaw

- Malocclusion
 - Underbite
 - Overbite
- Jaw luxation
- Luxation mandibular coronoidal process
- Trigeminal paralysis
- Craniomandibular osteopathy
- Inflammation
- Fracture
- Neoplasm

Foot

- Phalanx luxation
- Polydactyly
- Split hand
- Anomalia
- Inflammation
- Fracture
- Neoplasm

French Bulldog

In the French Bulldog, UKG database analysis was performed for the disciplines Ophthalmology, KNO (ears, upper airway), Orthopaedics/Neurology (vertebral column) and Reproduction. The same as for Chihuahuas, not enough samples were documented to be able to statistically test the discipline Reproduction. For the other disciplines, the three most diagnosed disorders and the results of the statistical test are shown in table 3.1- table 3.3. Statistically significant values are marked with *, if $P < 0.05$.

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Table 4.1: French Bulldog, Results statistical analysis Ophthalmology

Ophthalmology	French Bulldog	Crossbreed	p-value (FE)
Cataract	11	51	0,161
Ulcus	9	10	0,043*
Glaucoma	4	12	1,000
Total	57	180	

Table 4.2: French Bulldog, Results statistical analysis KNO, ears

Ears	French Bulldog	Crossbreed	p-value (FE)
Otitis externa	9	18	1,000
Otitis media et interna	2	2	0,572
Miscellaneous	0	2	n.a.
Totaal	11	22	

Table 4.3: French Bulldog, Results statistical analysis KNO, upper airway

Upper airway	French Bulldog	Crossbreed	p-value (FE)
BOS (brachycephalic obstructive syndrome)	17	4	0,000*
Miscellaneous [°]	4	32	n.a.
Total	21	38	

[°] four different diseases, all diagnosed once in the French Bulldog.

Table 4.4: French Bulldog, Results statistical analysis Orthopaedics/Neurology (Vertebral column)

Vertebral column	French Bulldog	Crossbreed	p-value (FE)
Hernia	26	20	0,003*

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Degenerative lumbosacral stenosis	1	6	0,108
Miscellaneous	0	5	n.a.
Total	27	31	

In Ophthalmology the diagnosis ulcus was statistically significant, however, in the discipline Ears, no statistically significant diseases were found. In the differential diagnosis for the organ system linked to the discipline Ears, the priority of diseases did not change. The median age of occurrence of French Bulldogs suffering from ulcus, was statistically significant younger than the median age of occurrence in crossbreeds.

In Upper airway and Vertebral column, respectively BOS and hernia were assessed statistically significant. The median age of occurrence for French Bulldogs with BOS 1,8 years, whilst for crossbreeds 4,0 years, which is not statistically significant. French Bulldogs suffered from hernia, at a statistically significant younger median age compared to crossbreeds (respectively 3,1 years and 6,5 years).

The statistically significant findings change the differential diagnosis of the Upper airway, Eyes and Vertebral column. The breed-specific differential diagnoses for the French Bulldog are shown right in fig. 8 (Upper airway), fig 9 (Eyes) and fig. 10 (Vertebral column), left the general differential diagnoses are shown. The disorders concerned are highlighted in grey.

Fig. 9: French Bulldog-specific differential diagnosis Respiratory system - Upper airway

French Bulldog - Respiratory system – Upper airway	
Nose and sinusses	
○ Nasal planum	• Stenotic nares (due to BOS)
	• Stenotic nares
○ Rhinitis/sinusitis	• Aspergillosis
	• Aspecific/allergic
	• Idiopathic
○ Oronasal fistel	
○ Choanae-atresie	
○ Corpus alienum	
○ Trauma	
○ Neoplasm	

Pharynx, larynx and trachea

- Pharynx
 - Elongated soft palate (due to BOS)
 - Pharyngitis
 - Tonsillitis
 - Corpus alienum
 - Trauma
- Neoplasm
- Nasopharynx
 - Reverse sneezing
 - Corpus alienum

- Larynx
 - Laryngeal collaps
 - Grade 1: eversion laryngeal sacculi (due to BOS)
 - Grade 2: loss strength and medial relocation of arytenoid (processus cuneiformus)
 - Grade 3: collaps of arytenoid (processus corniculatus)
 - Laryngitis
 - Laryngeal paralysis
 - Trauma
 - Neoplasm
 - Vocal cords
 - Miscellanious
- Trachea
 - Tracheal collaps
 - Hypoplastic trachea
 - Tracheitis
 - Corpus alienum
 - Trauma
 - Neoplasm

Fig. 10: French Bulldog-specific differential diagnosis Eyes

French Bulldog - Eyes

- Cornea and sclera
 - Keratitis with ulceration
 - Lacerations
 - Superficial keratitis
 - Keratitis pannosa
 - Corneal dystrophy

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- Orbita
 - Retrobulbar process
 - Trauma
- Lacrimal apparatus
 - Keratoconjunctivitis sicca
 - Closure lacrimal punctum
- Eyelids
 - Cherry eye
 - Inflammation
 - Blepharitis
 - Meibomian cyst
 - Melbominitis
 - Congenital
 - Entropion
 - Ectropion
 - Distichiasis
 - Ectopic cilia
 - Trichiasis
 - Coloboma
 - Trauma
 - Neoplasm
- Conjunctiva
 - Conjunctivitis
- Globe
 - Glaucoma
 - Primary
 - Secondary
 - Trauma
 - Luxatio bulbi
 - Hyphaema
 - Congenital
 - Microphthalmia
- Uvea
 - Uveitis
 - Anterior
 - Posterior
 - Iris
 - Iritis
 - Iris cyst
 - Coloboma
 - Neoplasm
- Lens and vitreum
 - Cataract
 - Lensluxation
 - Coloboma
- Fundus and N. Opticus
 - Ablatio retinae
 - Neuritis N. Opticus
 - Progressive retina-atrophy (PRA)
 - Hereditary retinal dysfunction

Fig. 11: General (left) vs French Bulldog (right) differential diagnosis Vertebral column

French Bulldog - Vertebral column	
○	Hernia nuclei pulposi
○	Discospondylitis
○	Spondylosis
○	Hemivertebra
○	Too many vertebrae
○	Too little vertebrae
○	Scoliosis
○	Diffuse idiopathic skeletal hyperostosis (DISH)
○	Dens aplasia
○	Trauma
•	Fracture
•	Contusion
•	Distorsion
•	Luxation
○	Neoplasm

Labrador Retriever

The only discipline statistically relevant for the Labrador Retriever was Orthopaedics, with elbow dysplasia, CCL (cranial cruciate ligament) injury and neoplasia as most diagnosed diseases. The results of the statistical analysis are shown in table 4, statistically significant values are marked with *, if $P < 0.05$.

Table 5: Labrador Retriever, Results statistical analysis Orthopaedics

Orthopaedics	Labrador Retriever	Crossbreed	p-value (FE)
Elbow dysplasia	48	18	0,000*
CCL (cranial cruciate ligament) injury	26	27	0,879
Neoplasia	10	11	0,825
Total	137	136	

Elbow dysplasia occurred statistically significant more often in Labrador Retrievers compared to crossbreeds. This finding changes the differential diagnosis of musculo-skeletal system for the Labrador Retriever, compared to the general differential diagnosis. Both differential diagnoses are shown in fig. 11, to provide an accessible overview of the breed-related changes.

Fig. 12: General (left) vs Labrador Retriever (right) differential diagnosis Musculo-skeletal system

Labrador Retriever – musculo-skeletal system

Elbow joint

- Elbow dysplasia
 - Ununited anconeal process (UAP)
 - Fragmented coronoid process (FCP)
 - Osteochondrosis dissecans (OCD)
 - Elbow incongruity (EI)
 - Medial compartment syndrome (MCD)
- Osteoarthritis/-arthritis
- Elbow luxation
- Fracture
- Neoplasm

Stifle joint

- Patellar luxation
 - Medial
 - Lateral
- Patella alta
- Patella baja
- Cruciate ligament disorder
 - Cranial cruciate ligament (CCL) injury
 - Caudal cruciate ligament injury
- Meniscal injury
- Osteoarthritis/-arthritis
- Fabelar fracture/absence
- Fracture

Hip joint

- Hip dysplasia
- Avascular necrosis head of femur (Calvé-Legg-Perthes)
- Osteoarthritis/-arthritis
- Hip luxation
- Fracture
- Neoplasm

Remaining joints

- Osteoarthrosis/-arthritis
- Ankylosis
- Osteochondrosis (dissecans)
- Trauma
 - Fracture (intra-articular)
 - Contusion
 - Distorsion
 - Luxation
 - Arthritis (traumatic)
- Polyarthritis
- Polyarthropathy
- Neoplasm

Vertebral column

- Discospondylitis
- Spondylosis
- Hemivertebra
- Too many vertebrae
- Too little vertebrae
- Scoliosis
- Diffuse idiopathic skeletal hyperostosis (DISH)
- Dens aplasia
- Trauma
 - Fracture
 - Contusion
 - Distorsion
 - Luxation
- Neoplasm

Unspecified

Bone

- Fracture
- Inflammation
 - Panosteitis
 - Osteomyelitis
- Deformities
 - Varus
 - Valgus
 - Chondrodysplasia
 - Chondrodystrophy
 - Aplasia
- Bone diseases
- Osteopetrosis
- Osteomalacia
- Osteofibrosis
- Chondrodysplasia
- Hypertrophic osteodystrophy (HOD)
- Neoplasm

Muscles and tendons

- Tendon rupture
- Muscle contusion
- Muscle contraction
- Muscle fibrosis
- Muscle rupture
- Myositis
 - Generalised
 - Masticatory muscle myositis
- Tendinitis
- Tendovaginitis
- Tendon luxation
- Neoplasm

Jaw

- Malocclusion
 - Underbite
 - Overbite
- Jaw luxation
- Luxation mandibular coronoidal process
- Trigeminal paralysis
- Craniomandibular osteopathy
- Inflammation
- Fracture
- Neoplasm

Foot

- Phalanx luxation
- Polydactyly
- Split hand
- Anomalia
- Inflammation
- Fracture
- Neoplasm

5. Discussion

This study has assessed the influence of breed related disorders on differential diagnoses and the diagnostic process of a veterinarian. For the Chihuahua, French Bulldog and Labrador Retriever specific differential diagnoses were conducted, based on the incidence of certain disorders per breed. These new differential diagnoses, were compared to randomly set up differential diagnoses of the same organ systems. By statistically demonstrating that these differential diagnoses differ, the hypothesis is proved that breed certainly is of influence.

Although the tested hypothesis is proven correct, we could possibly have found more inherited diseases in the UKG database, if more data was available. In as little as 50% of all patients records, a diagnosis was documented. If no diagnosis was documented, these patients were not taken into consideration. Hereby, the number of data was often too little for hard statistically significant evidence and only the obvious cases came apparent. With hard statistically significant evidence, it would be possible to even remove disorders from the differential diagnosis in some breeds. For this purpose, more data is needed.

Data for this purpose could be collected by manually checking the patients records and extracting the non-documented diagnoses from other fields in the records. A threat of this system, is misinterpretation by researchers and thus drawing conclusions to false diagnoses. Besides, this manual operation is extremely time-consuming. In pursuit of collecting more, solid, data from the UKG database in the future, a standardized way of documentation is recommended. If documentation at the UKG will be carried out carefully and in such a standardised way, an extremely valuable source will be created. The system of differential diagnoses ordered per organ system/anatomical sub-location we have developed and used here, based on international standard nomenclature, would be directly applicable and suitable for the UKG patient documentation system.

However, besides this non-foreseen disadvantage of using the UKG database as a source, one should be aware of certain limitations when using the database of a secondary care clinic. It is widely recognized that the clinical spectrum of diseases may be distorted in secondary care clinics, due to the selective referral of more severe or complicated cases. This phenomenon is called "referral bias" ([Nelson et al, 1987](#)). This referral bias was circumvented by first studying the situation in first line practices, which represent the current companion animal population in the Netherlands. Based on the results in first line practice, further investigation was performed at the UKG. Combining first and secondary care databases in research, a reliable source of information is created for this research.

Consequently, all in first line practice selected organ systems, were expected to show statistically significant disorders in the selected breeds. However, this did not point out to be correct for all selected organ systems. For example, the difference in occurrence of the most diagnosed ear disease in French Bulldogs,

otitis externa, was not statistically significant compared to crossbreeds. The most likely explanation is that the UKG database contains only diseases which are more or less frequently referred by first line practice. A disease like otitis externa will usually be easily diagnosed and treated in first line practice and therefore not be represented in the UKG database.

Another remarkable finding in this study, is the extremely few Chihuahuas, French Bulldogs and crossbreeds consulting the discipline Reproduction. A possible reason could be a lack of documentation, which is unlikely because all patients visiting the UKG must have a patient record (with or without diagnosis) in order to pay for their consult. An alternative reason for the low number of patients in this discipline, is that the diseases pointed out as important (Meijndert, 2013), are solved in first line practice. This makes sense, as dystocia, the most important problem seen in first line practice, is treated with a first line operation – a caesarian. Consequently, these patients do not consult secondary care clinics and are not recorded in the UKG database. The aforesaid “referral bias” interferes with the results of this study.

Apart from the few disciplines not showing disorders significantly over-represented in certain breeds, the majority of studied disciplines did. The priority in four differential diagnoses has changed based on breed, which can be useful for the veterinarian with a Chihuahua, French Bulldog or Labrador Retriever in his/her consulting room. A dog with a musculo-skeletal problem, being a Chihuahua, is at higher risk of patellar luxation than a crossbreed dog. Thus, the differential diagnosis for a lame Chihuahua, differs from the differential diagnosis of a lame crossbreed dog. The results of this study simplify the prioritising in differential diagnoses, since statistically significant breed-related differences can support the veterinarians’ experience. Although medical history and careful clinical examination remains extremely important, by simplifying the prioritising in differential diagnoses, the choice for additional research, or even treatment, is facilitated. This study revealed only four differential diagnoses to be changed by breed, one can imagine that with more, carefully documented data and more research, breed-specific differential diagnoses per organ system can be conducted, positively contributing to first line veterinary practice.

6. Conclusion

This study identified that breed standard related disorders and inherited diseases in a pedigree population influence the priority in differential diagnosis and the diagnostic process. By combining first en secondary care databases in this research, the differential diagnoses for several organ systems differed between pedigree dogs and crossbreeds. These findings facilitate prioritising in differential diagnoses of consulting purebred dogs, positively influencing the diagnostic process.

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Mosby

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9. Attachments

Annex 1: Differential diagnoses per organsystem

(Conroy et al, 1996; Dewey, 2003; Ettinger et al, 2009; Fossum et al, 2013; Jacobson, 2002; Mauldin et al, 2003; Medleau et al, 2006; Nelson et al, 2009; Nuttal et al, 2009; Olivry et al, 2001; Patel et al, 2008; Plat et al, 2001; Rijnberk et al, 2010; Rossner et al, 2004; Saridomichelakis et al, 2007; Stades et al, 2007; Vroom et al, 2006; www.venomcoding.org; www.whocc.no/actvet)

Spijsverteringskanaal en metabolisme	
Mond en keel	
o	Gebit
·	Malocclusie
·	Gebitsprobleem
	§ Formatieve afwijkingen
	§ Doorbraakafwijkingen
	§ Verkleuringen
	§ Postformatieve afwijkingen
o	Speekselklier
·	Speekselcyste
·	Sialodentitis
·	Sialolithiasis
o	Oropharynx
·	Feline eosinofiel granuloomcomplex
·	Feline lymfocytair-plasmacytair gingivitis/pharyngitis
·	Stomatitis
·	Gingivitis
·	Periodontitis
·	Glossitis
·	Cheilitis
·	Linguale paralyse
·	Cricopharyngeale achalasia
·	Pharyngeale dysfagie
·	Oronasale fistula
·	Te lang palatum molle
·	Te kort palatum molle /defect
·	Palatoschisis
·	Storing slikmechanisme
o	Kauwspieren
·	Kauwspiermyositis
·	Atrofische myositis
o	Kaakluxatie

The influence of breed standard related disorders and inheritable diseases in pedigree dogs on differential diagnoses and the diagnostic process.

o Niet openen van de bek
o Corpus alienum
o Trauma
o Neoplasie
Maag-darmkanaal
Oesophagus
o Slokdarmvernauwing
· Stenose of strictuur
§ Congenitaal
§ Verkregen
o Slokdarmobstructie
o Slokdarmverwijding
· Megaoesophagus
§ Primair
§ Secundair
o Oesophagitis
· Refluxoesophagitis
o Oesophageale dysfagie
o Motiliteitsprobleem
o Corpus alienum
o Trauma
o Neoplasie
Maag
o Maagdilatatie-volvulus
o Gastritis
· Infectieus
· Immuungemedieerd
o Maagulcera
· Spontaan
· Door NSAID's
o Pylorusstenose
· Congenitaal
· Verkregen
o Maagperforatie (ruptuur)
o Maagledigingsprobleem / motiliteitsproblemen
o Verminderde receptieve relaxatie
o Corpus alienum
o Neoplasie
Dunne darm
Ileus
o Niet-stranglerende ileus
· Corpus alienum
· Paralytische ileus
· Neoplasie
o Stranglerende ileus

The influence of breed standard related disorders and inheritable diseases in pedigree dogs on differential diagnoses and the diagnostic process.

· Darminvaginatie
· Mesenteriale torsio/volvulus
Diarree
o Voeding
o Infectieus
o Maldigestie
· EPI
· Ernstige galwegobstructie
o Malabsorptie
· Enteritis
§ Lymfo/plasmacytaire enteritis (IBD)
§ Eosinofiele enteritis
§ Granulomateuze enteritis
· Protein loosing enteropathie
· Basenji enteropathie (Lundehond)
· Lymfangiectasieën
· Motiliteitsproblemen
· Poliepen darmwand
· Neoplasie darmwand
Dikke darm
Obstipatie/constipatie
o Voeding
o Pijn
o Neuropathie
o Obstructie
· Congenitaal
§ Atresia ani
· Externe compressie
§ Bekkenfractuur
§ Neoplasie
· Colon/rectum strictuur
· Anaalklierprobleem
· Colon/rectumpoliep
· Corpus alienum
· Neoplasie
o (Idiopathisch) megacolon
· Primair
· Secundair
Diarree
o Infectieus
o Colitis
· Lymfo/plasmacytaire colitis
· Eosinofiele colitis
· Boxer chronische histiocytaire ulceratieve colitis
o Proctitis

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o Motiliteitsproblemen
o Voedsel gerelateerd
Anus en omgeving
o Anale sacculitis
o Hernia perinealis
o Anus strictuur
o Anus poliep
o Rectum prolaps
o Proctitis
o Atresia ani
o Kramp anus, onvoldoende relaxatie bij defaecatie
o Neoplasie
Lever, galwegen en vena porta
Leverparenchym
o Chronische hepatitis
· Idiopathisch
· Koperstapeling
· Infectieus
o Acute hepatitis
· Idiopathisch
· Infectieus
o Secundaire veranderingen
· Hypoxie
· Reactielever
· Toxisch
· Leververvetting
· Steroid geïnduceerde hepatopathie (= hepatopathie)
o Amyloidose
o Nodulaire hyperplasie
o Neoplasie
Galwegen
o Cholangitis/Cholecystitis
· Lymfocyttaire cholangitis
· Neutrofiële cholangitis
o Cyste
o Mucocele
o Extrahepatische galgangobstructie
· Ontsteking pancreas, duodenum, galgangen
· Neoplasie galgangen, pancreas
· Strictuur galgang
· Cholelithiasis
o Galblaasruptuur
o Neoplasie
Vena porta
o Congenitale portosystemische shunt

The influence of breed standard related disorders and inheritable diseases in pedigree dogs on differential diagnoses and the diagnostic process.

· Intrahepatisch
· Extrahepatisch
o Vena porta hypoplasie
o Arterio-veneuze fistel
Exocriene pancreas
o Pancreatitis
· Acuut
· Chronisch
o Exocriene pancreas insufficiëntie (EPI)
o Pancreas abces
o Pancreas cyste
o Triaditis
o Neoplasie
Bloed en bloedvormende organen
Anemie
Regeneratief
o Hemolyse
· Parasitair (Babesia)
· Immunologisch
§ Primair (Immuungemedieerde Hemolytische Anemie - IHA)
§ Secundair
· Mechanisch/fysische beschadiging
· Intoxicatie
· Alkalose
· Congenitaal
§ Pyruvaat kinase deficientie
§ Fosfofructokinase deficientie
o Bloedverlies
Non-regeneratief
o Gestoorde erythropoïese
· Chronische ziektes
· Beenmerg
§ Pure red cell aplasia
· Acuut bloedverlies of hemolyse (<48-96 uur)
· Endocrien
o Ijzerebreksanemie
Hemorragische diathese
Stoornis primaire hemostase
o Thrombocytopenie
· Verhoogd gebruik
§ Diffuse Intravasale Stolling (DIS)
· Verminderde aanmaak (beenmerg)
· Verhoogde afbraak
§ Immuungemedieerde Thrombocytopenie (ITP)

The influence of breed standard related disorders and inheritable diseases in pedigree dogs on differential diagnoses and the diagnostic process.

o Thrombocytopathie
· Medicijnen
· Uremie
Stoornis secundaire hemostase
o Congenitaal
· Hemofilie A
· Hemofilie B
· Ziekte van von Willebrand
o Verkregen
· Vitamine K deficiëntie
· Leverfunctiestoornis
Polycytemie
Milt
o Splenitis
o Miltruptuur
o Milttorsie
o Neoplasie
Cardiovasculair systeem
Bloedvat
o Vasculitis
o A. pulmonalis
· Wormen
· Pulmonale hypertensie
o Hypertensie
· Hyperaldosteronisme
· Nierfalen
· Idiopatisch
o Trombose
· A. femoralis
· V. cava
Endocard
o Endocarditis
o Myxomateuze klepdegeneratie
· Mitralis
· Tricuspidalis
Myocard
o Cardiomyopathie
· Dilaterende cardiomyopathie
· Hypertrofische cardiomyopathie
· Myocarditis
· Restrictieve cardiomyopathie
o Infarct
o Neoplasie
Pericard

The influence of breed standard related disorders and inheritable diseases in pedigree dogs on differential diagnoses and the diagnostic process.

o Pericardovervulling
· Primair
· Neoplasie
· Hartfalen
o Pericarditis
Prikkelvorming
o Abnormaal atriaal ritme
o Atriumfibrillatie
o Atriumflutter
o Ventriculaire extrasystolen
Prikkelgeleiding
o Atrioventriculair blok
· 1e graads
· 2e graads
· 3e graads
o Bundeltakblok
o Sino-auriculair blok
Congenitale afwijkingen
o Klepdefecten
· Mitralisdysplasie
· Tricuspidalisdysplasie
o Peritoneopericardiale hernia
o Atriumseptum defect
o PDAB
o Tetralogie van Falot
o Ventrikelseptum defect
o Stenose
· Aortastenose
· Double chambered rechter ventrikel
· Mitralis stenose
· Pulmonalisstenose
· Tricuspidalis stenose
Huidaandoeningen
Niet infectieus
o Allergien
· Urticaria
· Angio-oedeem
· Atopie
· Voedselovergevoeligheid
· Contactallergie
· Vlooiënallergie
o Auto-immuun en immuungemedieerd
· Pemphigus (verschillende vormen)
· Discoïde Lupus Erythematosus (DLE)

The influence of breed standard related disorders and inheritable diseases in pedigree dogs on differential diagnoses and the diagnostic process.

· Systemische Lupus Erythematosus (SLE)
· Steriele nodulaire panniculitis
· Idiopathisch steriel (pyo)granuloom
· Juvenile cellulitis
· Medicijnreactie (drug eruption)
· Toxische epidermale necrolyse (TEN)
· Cutane vasculitis
o Alopecia (congenitaal, verkregen, erfelijk)
· Alopecia X
· Canine seasonal flank alopecia
· Anageen en telogeen effluvium
· Post-clipping alopecia
· Alopecia areata
· Kleurmutant alopecia
· Pattern baldness
· Pre-auriculaire alopecia
· Pinna alopecia
· Feline paraneoplastische alopecia
· Psychogene kaalheid
· Zwarthaarfollikeldystrofie
· Endocriene kaalheid zie Verstoringen systemische hormoonbalans
o Congenitale aandoeningen
· Dermatomyositis
· Ehler-Danlos syndroom
· Cutane mucinose
· Dermoid sinus
· Feline hypotrichose
o Pigment afwijkingen
· Vitiligo
· Nasale depigmentatie
· VKH syndroom: uveodermaal syndroom
o Keratinisatie stoornis
· Idiopathische seborroe
· Staartklierhyperplasie
· Zink responsieve dermatose
· Canine acne
· Sebaceous adenitis/talgklier adenitis
· Hepato-cutaan syndroom (SNME)
· Ear margin dermatosis
· Ichthyose
· Schnauzer comedo syndroom
· Idiopathische nasodigitale hyperkeratose
· Voetzool hyperkeratose
· Feline acne
· Facial dermatitis

The influence of breed standard related disorders and inheritable diseases in pedigree dogs on differential diagnoses and the diagnostic process.

o Overig
· Callus
· Lik granuloom
· Anale furunculose
· Anaalzakontstekingen
· Nagelafwijkingen
· Eosinofiel granuloom complex
· Feline plasmacel pododermatitis
· Feline idiopatische ulceratieve dermatose
· Neoplasie
Infectieus
o Bacterieel
o Viraal
o Schimmel
o Ectoparasitair
o Protozoair (Leishmania)
o Rickettsia
Urogenitaalstelsel
Geslachtsorganen en melkklieren
Vrouwelijk geslachtsapparaat
o Ovarium
· Ovariumcyste
· Neoplasie
o Uterus, cervix
· Cysteuze endometrium hyperplasie (niet gecompliceerd)
· Mucometra
· Endometritis post partum/acute puerperale endometritis
· (CEH) Endometritis post oestrus met open cervix
§ na gebruik progestagenen
· (CEH) Endometritis post oestrus gesloten cervix (pyometra)
§ na gebruik progestagenen
· Subinvolutie placentaplaatsen
· Inversio et prolapsus uteri
· Neoplasie
o Vagina, vestibulum, vulva
· Vaginitis
§ Juvenile vaginitis (ongecompliceerd)
§ Volwassen teef
- Intact
- Niet-intact
· Vagina plooihyperplasie
· Vaginaal septum
· Neoplasie
o Melkklieren

The influence of breed standard related disorders and inheritable diseases in pedigree dogs on differential diagnoses and the diagnostic process.

· Neoplasie
· Mastitis
· Fibro-adenomateuze hyperplasie
o Dracht/partus
· Resorptie
· Abortus
§ Compleet
§ Partieel
· Torsio uteri
· Dystocia
§ Weëenzwakte
§ Te grote vrucht (absoluut of relatief)
§ Afwijkende ligging
§ Monstrum
o Cyclus
· Persistierende anoestrus
§ Primair (nooit loops geweest)
§ Secundair (eerder wel loops geweest)
· Persistierende loopsheid ((pro)-oestrus)
§ Granulosaceltumor
§ Ovariele follikel cyste
· Schijndracht
· Anovulatoire loopsheid
· Split heat
Mannelijk geslachtsapparaat
o Testis en scrotum
· Onvruchtbaarheid (sperma-afwijking)
· Cryptorchidie
· Vertraagde descensus testiculorum (> 9 wkn post partum)
· Orchitis/epididymitis)
· Scrotitis
· Hernia inguinalis/scrotalis
· Testikel torsie
· Trauma
· Neoplasie testikel
· Neoplasie scrotumhuid
o Prostaat
· Benigne prostaahyperplasie
· Prostatitis
· Prostaatabces
· Prostaatcyste
· Neoplasie
o Penis en preputium
· Balanoposthitis
· Phimosis

The influence of breed standard related disorders and inheritable diseases in pedigree dogs on differential diagnoses and the diagnostic process.

· Paraphimosis
· Priapisme
· Persisterend frenulum preputiale
· Trauma
§ Fractuur os penis
· Neoplasie
Ongespecificeerd
o Afwijkende geslachtelijke ontwikkeling
Blaas
o Cystitis
· Bacterieel
· Urolithiasis
· Chronisch met poliepvorming
· Idiopathisch
· Immunoplasmacellulair
o Dysfunctie
· Sfincter incontinentie
· Detrusor instabiliteit
· Overloopblaas
· Blaasatonie
o Blaasruptuur
o Congenitaal
· Pelvic bladder
· Blaasdivertikel
· Litteken urachus
· Hypoplasie blaas
o Neoplasie
Urinewegen
Urethra
o Urethritis
· Infectieus
· Immunoplasmacellulair
· Fibrose
o Obstructie
· Urolithiasis
· Strictuur
· Urethrale reflex dyssynergie
· Neoplasie
Ureter
o Obstructie
· Urolithiasis
· Strictuur
· Neoplasie
Systemische hormoonbalans

The influence of breed standard related disorders and inheritable diseases in pedigree dogs on differential diagnoses and the diagnostic process.

Hypofyse, Hypothalamus en bijnieren
o Acromegalie
· Hypofysair
· Progesteron-geïnduceerd (mammair)
· Progestageen-geïnduceerd (mammair)
· Ten gevolge van hypothyreoïdie
o Groeihormoondeficiëntie
· Congenitaal (dwerggroei)
· Verkregen
o Diabetes insipidus
· Centraal
· Nefrogeen
o Primaire polydipsie
o Hypercortisolisme (syndroom van Cushing)
· Hypofyse-afhankelijk
· Bijnier afhankelijk
· Ectopische ACTH secretie
· Iatrogeen
o Hypoadrenocorticisme
· Primair (ziekte van Addison)
· Secundair
· Relatieve bijnierschorsinsufficiëntie
· Iatrogeen
o Hyperaldosteronisme
· Neoplasie
· Idiopathisch
o Pheochromocytoom
o Niet-producerende hypofysetumor
o Niet-producerende bijnertumor (incidentaloos)
Schildklier
o Hypothyreoïdie
· Primair
· Secundair (centraal)
o Sick euthyroid syndrome/non-thyroidal illness
o Hyperthyreoïdie
· Schildkliertumor
· Voedsel-afhankelijk
o C-celtumor (medullair carcinoom)
o Niet-producerende schildkliertumor
Bijschildklier
o Primaire hypoparathyreoïdie
o Secundaire hypoparathyreoïdie
· Alimentair
· Renaal
o Primaire hyperparathyreoïdie

The influence of breed standard related disorders and inheritable diseases in pedigree dogs on differential diagnoses and the diagnostic process.

o Pseudohyperparathyreoidie (paraneoplastische hypercalcemie)
Endocriene pancreas
o Diabetes mellitus
· Type 1 (immuun-gemedieerd)
· Type 2 (insuline-resistentie door life style factoren)
· Type 3 (insuline-resistentie door medicijnen of ziekten)
· Progesteron/progestoogeen geïnduceerd
o Insulinoom
o Gastrinoom
o Glucagonoom
Neoplastische aandoeningen
Lymfoïde leukemie
Myeloproliferatieve ziekten
Maligne lymfoom
Mastocytose
Multipel myeloom
Histiocytair sarcoom
Bewegingsstelsel
Heup
o Heupdysplasie
o Avasculaire femurkopnecrose (Calvé-Legg-Perthes)
o Osteoarthrose/-arthritis
o Heupluxatie
o Fractuur
o Neoplasie
Elleboog
o Elleboogdysplasie
· Los processus anconeus (LPA)
· Los processus coronoideus (LPC)
· Osteochondrose dissecans (OCD)
· Elleboog incongruentie (EI)
· Medial compartment syndroom (MCD)
o Osteoarthrose/-arthritis
o Elleboogluxatie
o Fractuur
o Neoplasie
Knie
o Patellaluxatie
· Mediaal
· Lateraal
o Patella alta
o Patella baja
o Kruisbandlaesie

The influence of breed standard related disorders and inheritable diseases in pedigree dogs on differential diagnoses and the diagnostic process.

· Voorste kruisband laesie
· Achterste kruisband laesie
o Meniscuslaesie
o Osteoarthrose/-arthritis
o Fabella afwezigheid
o Fractuur (incl. fabella)
Overige gewichten
o Osteoarthrose/-arthritis
· Ankylose
· Hypervitaminose A
o Osteodystrofie
· Hak (Scottisch Fold)
o Osteochondrose (dissecans)
· Schouder
· Hak
· Lumbosacraalgewricht
o Trauma
· Fractuur (intra-articulair)
· Contusie
· Distorsie
· Luxatie
· Arthritis (traumatisch/septisch)
o Polyarthritis
o Polyarthropathie
o Neoplasie
Wervelkolom
o Discospondylitis
o Spondylose
o Hypervitaminose A
o Hemivertebra (wervelmalformatie)
o Te veel wervels
o Te weinig wervels
o Scoliosis
o Diffuse idiopathische skelet hyperostose (DISH)
o Intervertebrale discusdegeneratie
o Aplasie van de dens
o Trauma
· Fractuur
· Contusie
· Distorsie
· Luxatie
o Neoplasie
Kaak
o Onderbijter
o Overbijter

The influence of breed standard related disorders and inheritable diseases in pedigree dogs on differential diagnoses and the diagnostic process.

o Kaakluxatie
o Luxatie processus coronoideus mandibularis
o Craniomandibulaire osteopathie
o Ontsteking
o Fractuur
o Neoplasie
Ondervoet
o Luxatie falanx
o Polydactilie
o Split hand
o Anomalie
o Ontsteking
o Fractuur
o Neoplasie
Ongespecificeerd
Bot
o Fractuur
o Ontsteking
· Panosteitis
· Osteomyelitis
o Standafwijkingen
· Varus
· Valgus
· Chondrodysplasie
· Chondrodystrofie
· Aplasie
o Botstofwisselingsstoornissen
· Osteopetrosis
· Osteomalacie
· Osteofibrosis
· Chondrodysplasie
· Hypertrofische osteodystrofie (HOD)
· Neoplasie
Spiere en pezen
o Spiercontusie
o Spiercontractie
o Spierfibrosing
o Spierverscheuring
o Myositis
· Gegeneraliseerd
· Kauwspiermyositis
o Peesruptuur
o Tendinitis
o Tendovaginitis bicepspees
o Peesluxatie (biceps/achillus)

The influence of breed standard related disorders and inheritable diseases in pedigree dogs on differential diagnoses and the diagnostic process.

o Neoplasie
Zenuwstelsel
Hersenen
o Inflammatoir
· Niet infectieuze encephalitis/meningitis
§ Steroid-responsive meningitis-arteritis (SRMA)
§ Granulomateuze meningo-encefalitis (GME)
· Infectieuze encephalitis/meningitis (o.a. hond: Toxoplasma/kat: FIP)
o Epilepsie
· Primair
· Secundair
o Metabool
· Hypoglycemie
· Hypocalcemie
· Hepatoencefalopathie
· Electrolytenafwijkingen
· Uremische encephalopathie
o Degeneratieve aandoeningen
· L-2-Hydroxyglutarische acidurie (L-2-HGA)
· Cerebellaire abiotrofie
o Intoxicatie
o Vasculair (hypertensie)
o Congenitaal
· Hydrocephalus
· Chiari-like malformation
· Arachnoidale cyste
· Cyste zakje van Rathke
o Trauma
o Neoplasie
Ruggenmerg cervicaal
o Inflammatoir
· Myelitis (FIP)
· Steroid responsieve meningitis-arteritis (SRMA)
· Discospondylitis
o Cyste
· Arachnoidale cyste
· Dermoid cyste
o Degeneratieve aandoeningen
· Hernia nucleus pulposus
· Cervicospondylomyelopathie (Wobbler)
· Degeneratieve leucoencefalomyelopathie
o Vasculair
· Bloeding
· Embolische myelopathie (FCE)
o Congenitaal

The influence of breed standard related disorders and inheritable diseases in pedigree dogs on differential diagnoses and the diagnostic process.

· Atlanto-axiale subluxatie
· Syringohydromyelië
o Trauma
· Fractuur
· Luxatie
o Neoplasie
Ruggenmerg thoracolumbaal
o Inflammatoir
· Myelitis (FIP)
· Discospondylitis
o Cyste
· Arachnoidale cyste
· Dermoid cyste
o Degeneratieve aandoeningen
· Hernia nucleus pulposus
· Degeneratieve myelopathie
· Degeneratieve leucoencephalomyelopathie
o Vasculair
· Embolische myelopathie (FCE)
· Bloeding
o Congenitaal
· Malformatie wervelkolom
o Trauma
· Fractuur
· Luxatie
o Neoplasie
Ruggenmerg lumbosacraal
o Inflammatoir
· Myelitis (FIP)
· Discospondylitis
o Cyste
· Arachnoidale cyste
· Dermoid cyste
o Degeneratieve aandoeningen
· Hernia nucleus pulposus
· Degeneratieve myelopathie
· Lumbosacrale stenose / Cauda equina syndroom
o Vasculair
· Embolische myelopathie (FCE)
· Bloeding
o Congenitaal
· Spina bifida
· Sacrocaudale dysgenese
o Trauma
· Fractuur

The influence of breed standard related disorders and inheritable diseases in pedigree dogs on differential diagnoses and the diagnostic process.

· Luxatie
o Neoplasie
Perifere zenuwen
o Focale neuropathieën
· Idiopatische Facialis paralyse
· Idiopatische Trigemini paralyse (o.a. onderkaakverlamming)
· Horner's syndroom
o Vasculair
· Ischemische neuropathie (thrombus)
o Immungemedieerd
· Polyradiculoneuritis
· Verkregen myasthenia gravis
o Congenitale myasthenia gravis
o Degeneratieve aandoeningen
· Dysautonomie
o Metabool
· Hypokalemie
o Intoxicatie
· Botulisme
o Trauma
· Avulsie plexus brachialis
o Neoplasie
Respiratoire stelsel
Neus en nevenholten
o Rhinitis/sinusitis
· Infectieus (bacterieel/viraal/mycotisch)
· Aspecifiek (lymfoplasmacellulair)
o Oronasale fistel
o Corpus alienum
o Nasopharyngeale poliep
o Neoplasie
o Planum nasale
· Stenotische neusgaten
· Stenotische neusgaten tgv BOS
Pharynx, larynx en trachea
o Nasopharynx
· Corpus alienum
o Pharynx
· Te lang palatum molle tgv BOS
· Pharyngitis
· Tonsillitis
· Corpus alienum
· Trauma
· Neoplasie
o Larynx

The influence of breed standard related disorders and inheritable diseases in pedigree dogs on differential diagnoses and the diagnostic process.

· Laryngitis
· Larynx paralyse
· Larynx collaps
§ Graad 1: eversio laryngeale sacculi tgv BOS
§ Graad 2: verlies stevigheid en mediale verplaatsing arytenoid (processus cuneiformus)
§ Graad 3: collaps arytenoid (processus corniculatus)
· Trauma
· Neoplasie
o Trachea
· Tracheïtis
· Trachea collaps
· Hypoplastische trachea
· Trauma
· Corpus alienum
· Neoplasie
Diepere luchtwegen
o Bronchiën
· Bronchiectasie
· Bronchitis
§ Acuut
§ Allergisch (feline astma)
§ Chronisch
§ Infectieus (kennelhoest)
§ Parasitair (longworm)
· Corpus alienum
· Neoplasie
o Longparenchym
· Atelektase
· Intoxicatie
§ Rook
· Longbloeding
· Longcontusie
· Longcysten
· Longemfyseem
· Longfibrose
· Longkwabtorsie
· Longoedeem
§ Cardiogeen
§ Non-cardiogeen
· Longontsteking
§ Aspiratie
§ Infectieus (bacterieel/viraal/mycotisch)
§ Interstitieel

The influence of breed standard related disorders and inheritable diseases in pedigree dogs on differential diagnoses and the diagnostic process.

§ Lobair
· Longtumoren
§ Primair
§ Metastasen
· Pneumonitis eosinophila
· Pulmonale hypertensie
§ Idiopatisch
§ Linker hartfalen
§ Wormen
Niet gespecificeerd
o Diafragma
· Hernia diafragmatica
§ Congenitaal
§ Verkregen (traumatisch)
· Verlamming
o Mediast
· Emfyseem
· Neoplasie
· Thymus
§ Neoplasie
o Pleurale holte
· Liquothorax
§ Feline infectieuze peritonitis (FIP)
§ Chylothorax
§ Hemothorax
§ Linker hartfalen
§ Neoplasie
§ Pleuritis
§ Rechter hartfalen
§ Stuwing
· Pneumothorax
§ Spontaan
§ Trauma
o Thoraxwand
· Ribben
§ Fractuur
§ Neoplasie
· Sternum
§ Fractuur
Oren
o Pinna
· Othematoom
· Ontsteking
· Neoplasie
o Otitis externa

The influence of breed standard related disorders and inheritable diseases in pedigree dogs on differential diagnoses and the diagnostic process.

· Proliferatief
§ Neoplasie
§ Idiopathische inflammatoire/hyperplastische dermatitis
§ Chronische otitis externa
· Ulceratief
§ Corpus alienum
· Ceruminosa
§ Overgevoeligheid/allergie
§ Parasitair
§ Endocriene aandoening
· Cushing
§ Keratinisatiestoornis
· Hypothyreoidie
· Hyperadrenocorticisme
· Sebaceous adenitis/talgklier adenitis
· Idiopathische seborroe
§ Auto-immuun aandoeningen
· Pemphigus
· SLE (systemische lupus erythematosus)
· IHA (immuungemedieerde hemolytische anemie)
o Otitis media/interna
· Idiopathische otitis media
· Otitis externa
· Cholesteatoom
· Primary Secretory Otitis Media (PSOM)
· Corpus alienum
· Neoplasie
o Atresie gehoorgang
Congenitale doofheid
Ogen
· Orbita
o Retrobulbair proces
o Trauma
· Traanapparaat
o Keratoconjunctivitis sicca
o Traanafvoerbelemmeringen
· Oogleden
o Cherry eye
o Ontsteking
§ Blepharitis
§ Meiboom cyste
§ Melbominitis
o Congenitaal
§ Entropion
§ Ectropion

The influence of breed standard related disorders and inheritable diseases in pedigree dogs on differential diagnoses and the diagnostic process.

§ Distichiasis
§ Ectopische cilien
§ Trichiasis
§ Coloboma
o Trauma
o Neoplasie
· Conjunctiva
o Conjunctivitis
· Oogbol
o Glaucoom
§ Primair
§ Secundair
o Trauma
§ Luxatio bulbi
§ Hyphaema
o Congenitaal
§ Microphthalmie
· Cornea en sclera
o Verwondingen
o Oppervlakkige keratitis
o Keratitis met ulceratie
o Keratitis pannosa
o Cornea dystrophie
· Uvea
o Uveitis
§ Anterior
§ Posterior
o Iris
§ Iritis
§ Iris cyst
§ Coloboma
o Neoplasie
· Lens en vitreum
o Cataract
o Lensluxatie
o Coloboma
· Fundus en N. Opticus
o Ablatio retinae
o Neuritis N. Opticus
o Progressieve retina-atrofie (PRA)
o Erfelijke retina dysfunctie