Institution: Royal Veterinary College
Unit of Assessment: A 6 Agriculture, Veterinary and Food Science
Title of case study: Improving health of pedigree dog breeds
1. Summary of the impact (indicative maximum 100 words)

Veterinarians have long recognised health problems associated with in-breeding and extreme conformation in various pedigree dogs. However, the 'Pedigree Dogs Exposed' documentary in 2008, which particularly featured the plight of Cavalier King Charles Spaniels (CKCS), and resultant independent inquiry reports, to which RVC contributed, brought the extent and severity of the issue into the public eye. RVC's ongoing programme of research linked to interaction with stakeholders has contributed to the changes in breed standards instituted by the Kennel Club (KC); understanding of underlying principles governing the relationship between structure and function and affecting desired traits; developing tools to address conformation-related health problems; and driving changes in breeding practice leading to healthier dogs.

2. Underpinning research (indicative maximum 500 words)

Dr Clare Rusbridge, a veterinary neurologist now working in private referral practice, was largely responsible for bringing the problem of Chiari-like malformation and syringomyelia (CM/SM) in CKCS to light: publishing with RVC colleagues and others a paper which first described syringomyelia secondary to deformity of the caudal fossa and overcrowding of the foramen magnum [1]. This was sparked by her observation, whilst at the RVC (1994-1997 as Senior Training Scholar and then Staff Clinician), of a syndrome of persistent scratching in CKCS, which, through correspondence with general practitioners, was shown to be common in the breed. Studies at RVC continued to characterise the anatomical basis of the syndrome [2] suggesting over-crowding of the caudal cranial fossa (CCF) occurred. More recently, Dr Holger Volk (progressing from internship and residency from 2004, to Senior Lecturer in Veterinary Neurology and Neurosurgery), together with Dr Imelda McGonnell (from 2004, Lecturer and then Senior Lecturer in Reproduction and Development), in collaboration with Rusbridge clearly demonstrated that the syndrome in CKCS was related to oversize of the cerebellum relative to the CCF. Although clinical signs do not correlate with degree of cerebellar herniation [3], the presence of SM is related to the size of the cerebellum leading to over-crowding of the caudal part of the CCF [4].

Most recently, the research team has linked this to continuance of juvenile appearance and traits into adulthood, particularly of gait, which is known to be controlled by the cerebellum (to be published shortly). As the puppyish characteristics are viewed as major part of their appeal, this presents a real challenge to modifying the breed. The Animal Welfare team has undertaken sociological studies which are addressing similar issues of breed appeal and (un)awareness of health and welfare issues: for example, documenting the lack of perception of breathing problems (including Brachycephalic Obstructive Airway Syndrome (BOAS)) in brachycephalic breeds [5]. This appreciation has helped the team in their interactions with owners and breeders, to encourage implementation of impact, and led to further research support from the Cavalier breed Club.

To assist the KC's commitment to qualitative changes in breed descriptors, to address breed-related problems, Dr Charlotte Burn, (Research Fellow from 2008 and Lecturer in Animal Welfare Science since 2010) set out to quantify conformation-related problems (slipped discs in long bodies [6]; and eye ulcers and breathing disorders in brachycephalics (submitted for publication 2013)), with the aim of adding quantitative limits to KC breed standards.

The CKCS and other breed health issues have connected to several other programmes of research at RVC, for instance into mitral valve disease – where the prevalence in CKCS is about twenty times that of other breeds (see case study 'Improving diagnosis and treatment of canine heart disease'). The need for quality data on prevalence and risk to identify the true scale of health issues, was a further concern highlighted in the inquiry reports triggered by the *Pedigree Dogs Exposed* documentary.

The RVC's VetCompass project, led by David Church (Professor of Small Animal Studies since 2001) and Dr David Brodbelt (Lecturer from 2004, then Senior Lecturer in Companion Animal Epidemiology from 2007), is now addressing this need. The database has grown to over 500,000 cases and has brought 180 private and charitable practices in the UK into participation in the research activity. One example of its use was a study using the (then) 89 primary veterinary clinics supplying data, to analyse prevalence, risk factors and survival from records of chronic kidney disease – again quantifying the higher risk in certain breeds - in 107,214 dogs [7].

Other Quality and Relevance Indicators

McGonnell. The Development of Occipital Hypoplasia (Chiari-like malformation) and syringomyelia in the Cavalier King Charles spaniel. £7,500. 2007-8. Cavalier King Charles Spaniel Club.
McGonnell and Volk. The development of Chiari-like malformation in the CKCS. £9,000. 2010-13. American CKCS Charitable Trust.
McGonnell and Volk. Identifying the molecular mechanisms of brain overgrowth in Chiari-malformation. £435,500. 2011-14. Wellcome Trust
£418,300 total funding from 6 animal welfare charity research grants 2010 – 2013.

3. References to the research (indicative maximum of six references)

1. Rusbridge, C, MacSweeny, JE, Davies, JV, Chandler, K, Fitzmaurice, SN, Dennis, R, Cappello, R, Wheeler, SJ. Syringohydromyelia in Cavalier King Charles spaniels. 2000 Journal of the American Animal Hospital Association; Jan-Feb;36(1):34-41. http://www.jaaha.org/content/36/1/34.full.pdf [accessed 16 Oct 2013]
2. Lu,D Lamb, CR, Pfeiffer, DU, Targett MP. Neurological signs and results of magnetic resonance imaging in 40 cavalier King Charles spaniels with Chiari type 1-like malformations. 2003 Veterinary Record; 153: 260-263. DOI: 10.1136/vr.153.9.260
3. Driver, CJ, Rusbridge, C, Cross, HR, McGonnell, I, Volk, HA. Relationship of brain parenchyma within the caudal cranial fossa and ventricle size to syringomyelia in cavalier King Charles spaniels. 2010. Journal of Small Animal Practice 51: 382-386 DOI.org/10.1111/j.1748-5827.2010.00952.x
4. Shaw, TA, McGonnell, IM, Driver, CJ, Rusbridge, C, Volk, HA. Increase in Cerebellar Volume in Cavalier King Charles Spaniels with Chiari-like Malformation and Its Role in the Development of Syringomyelia. 2012 PLoS ONE; 7(4): e33660. DOI:10.1371/journal.pone.0033660
5. Packer, RMA, Hendricks, A, Burn, CC. Do dog owners recognise clinical signs related to a conformational inherited disorder that is 'normal for the breed'? A potential constraint to improving canine welfare. 2012 Animal Welfare; 21(S1): 81-93 http://www.ingentaconnect.com/content/ufaw/aw/2012/00000021/A00101s1/art00010 [accessed 16 Oct 2013]
6. Packer, RMA, Hendricks, A, Shihab, N, Volk, H, Burn, CC. How long and low can you go? Effect of conformation on the risk of thoracolumbar intervertebral disc extrusion in domestic dogs. 2013. PLOS ONE 8: e69650 DOI.org/10.1371/journal.pone.0069650
7. O'Neill, DG, Elliott, J, Church, DB, McGreevy, PD, Thomson, PC, Brodbelt, DC. Chronic kidney disease in dogs in UK veterinary practices: prevalence, risk factors, and survival. 2013. Journal of Veterinary Internal Medicine; 27(4):814-21 DOI: 10.1111/jvim.12090

4. Details of the impact (indicative maximum 750 words)

In 2008, RVC contributed to the BBC1 documentary, *Pedigree Dogs Exposed*, which attracted 3.9 million viewers, and was responsible for three separate reports being commissioned into breed issues [a]. The programme highlighted, principally, a welfare concern, but noted additional economic impact, in added costs of veterinary care. It reported that pedigree animals make up 75% of the seven million dogs in the UK (estimated in 2012 to be 9.4 million) and cost their owners over £10m in veterinarians' fees each week. The chronic pain affecting CKCS afflicted by syringomyelia was presented as a particularly graphic illustration of a more general issue, and the writer and director, acknowledged the substantial contribution from RVC researchers to produce the programme and subsequently: *"I made particular use of RVC work on Chiari-like Malformation and Syringomyelia in Cavalier King Charles Spaniels […] RVC researchers and research findings were also extremely helpful in preparation of the follow-up documentary, in 2012, which reported*

progress but also ongoing concerns over these two [with BOAS] welfare issues. Amongst the breakthrough developments since the original programme, I would single out VetCompass for providing the UK-wide epidemiological data necessary to monitor canine health and welfare […] research originating from the Royal Veterinary College underpinned much of the content of Pedigree Dogs Exposed, ensuring the programme's claims could not be dismissed lightly. Furthermore, the lasting impact of the programme is due in no small part to the College's continued commitment to this issue." [b].

The first documentary was highly influential: resulting in the withdrawal of coverage for Crufts dog show by the BBC and termination of support by the Dogs Trust, the Royal Society for the Prevention of Cruelty to Animals and the People's Dispensary for Sick Animals.

RVC's research and expertise was used in each of the resulting inquiry reports [c,d,e], The reports also noted a lack of quality data on prevalence of breed related health problems. The Executive Summary in the report of the Associate Parliamentary Group for Animal Welfare noted: "*However, there is a lack of information available about the scale of the problem [health and welfare of many pedigree dogs], which makes it difficult to obtain a clear picture of what percentage of dogs are affected. As the Royal Veterinary College (RVC) has shown that the problem is widespread to different degrees of severity in many of the most popular breeds we believe further action must be taken immediately*." The Bateson inquiry included a call for evidence, and in the report, points from respondents included: "*A long list of heritable diseases affected dogs, but little or no hard data were available on prevalence. A few respondents pointed to the need for a system to collect data from veterinary surgeries, as being developed by the Royal Veterinary College*."

Each of the reports [c,d,e] concluded that current breeding practices were detrimental to the welfare of pedigree dogs. The Kennel Club subsequently completed its ongoing revision of its breed standards for every breed individually [f]. The revisions specify that standards "*will not include anything that could in any way be interpreted as encouraging features that might prevent a dog from breathing, walking and seeing freely*". For individual breeds, the revisions frequently include addition of 'relatively', 'moderately', 'no exaggeration' and 'not excessive' and deletion of 'massive', to descriptions of breed characteristics. Additionally, it sought to limit inbreeding by "*refusing to register those puppies that are born from any mother/son, father/daughter or brother/sister mating, taking place on or after 1st March 2009*". The Kennel Club's Genetics and Health Information Manager acknowledges RVC's role: *"RVC's research into both the causes and extent of breed-associated ill health and the extent of human perception of these conditions, has been extremely valuable in raising awareness and increasing understanding of health and welfare matters. Its work with breeders and breed clubs internationally has helped to ensure that the research outputs are taken into account and deliver tangible benefit in terms of a healthier dog population.*" [g]

An independent Advisory Council for welfare issues of dog breeding was established in 2010, with the support of the Dogs Trust, to pursue implementation of the other recommendations of the three reports [h]. Their Veterinary Director notes: "*RVC… contributed to the section [of the first annual report] relating to breathing difficulties and the majority of the other priorities (ocular problems, syringomyelia, idiopathic epilepsy and heart disease) are areas in which RVC research findings are contributing to canine health and welfare."* [i].

The perceived 'demonisation' of specialist breeders, and their initial rejection of the PDE documentary's claims, themselves created a barrier to improving welfare. Consequently, the RVC researchers have pursued a positive relationship with the pedigree clubs, guided by outputs from research into owners' (limited) perceptions of problems. They have developed partnerships with associations representing CKCS and other affected breeds, aided by the Kennel Club's overarching support for liaison between breeders and veterinary scientists, in order to involve them actively in work designed to improve health and welfare. Outputs from VetCompass have assisted, as anticipated by the inquiry reports, in providing firm evidence for scale and scope of specific problems.

The number of CKCS in the UK alone is estimated to easily exceed 65,000 (over 11,000 are now registered in a single year), making it the 6th most popular breed. There are also breed clubs

across Europe, North America, South Africa, Australia and New Zealand. All are said to be descended from six dogs. Studies of relatively small selected groups suggest that over 95% bear the Chiari-like malformation and, the majority of these may go on to develop SM. Other disorders in CKCS consequent on in-breeding are, unsurprisingly, common.
CKCS breeders' symposia, attracting around 60-70 participants were held in 2006 and 2010 and led to the Cavalier Club sponsoring research at RVC (see [2,3]), relating to the mismatch of brain and cranium size in CKCS. [text removed for publication]. Interim breeding guidelines were instituted, based on the research, discussion and report from the international Cavalier Club round table organised and hosted by RVC in 2006 [j]. Five years on from this, independent research showed a tangible impact on dog health and welfare: where a scheme was implemented to screen dogs by MRI. Where it was possible to select at least one parent that was SM-free at five years of age, the incidence of young dogs with severe clinical symptoms was reduced. The analysis showed 70% of CKCS offspring were unaffected by SM when both parents SM free; 77% were affected when one parent affected; and 92% affected when both parents affected. The publication also commented: "*One encouraging observation was that the proportion of grade E (SM-affected younger than 2.5 years of age) dropped from an average of 15 dogs per year in years 2004 to 2006 to 11 dogs per year in years 2007 to 2009, that is, the breeding guidelines may be achieving the goal of reducing the risk of early onset SM, however, this hypothesis would be needed to be tested in a more vigorous study*" [k]. A Kennel Club/BVA health screening scheme for Chiari Malformation/Syringomyelia in multiple breeds based on this pilot scheme was introduced in 2012 [l].

Thus work has progressed from demonstrating in-bred and conformational health problems, to highlighting the on-going ignorance of their effects [m], and involvement by the research team of breeders, owners and veterinarians, to determine the scale and specifics of problems to drive change in breeding practices.

5. Sources to corroborate the impact (indicative maximum of 10 references)

a.*Pedigree Dogs Exposed* (2008) BBC1 documentary, 19 Aug, 21h00. Extracts available online: http://topdocumentaryfilms.com/pedigree-dogs-exposed/ [accessed 6 Mar 2013]
b. Statement from Writer/director of Pedigree Dogs Exposed. Held by RVC.
c.http://www.rspca.org.uk/ImageLocator/LocateAsset?asset=document&assetId=1232712491490&mode=prd [accessed 12 Sep 2013]
d. http://breedinginquiry.files.wordpress.com/2010/01/final-dog-inquiry-120110.pdf [accessed 12 Sep 2013]
e. http://www.apgaw.org/data/sites/1/PDFs/a-healthier-future-for-pedigree-dogs.pdf [accessed 21 Oct 2013]
f. http://www.thekennelclub.org.uk/activities/dog-showing/breed-standards/about-breed-standards/ [accessed 1 Nov 2013] (features affecting health)
http://www.thekennelclub.org.uk/services/public/breed/restrictions.aspx?id=2058 [accessed 1 Nov 2013] (restricting in-breeding)
g. Statement from Genetics and Health Information Manager, The Kennel Club. Held by RVC.
h. http://www.dogadvisorycouncil.com/page2/index.php [accessed 6 Mar 2013]
i. Statement from Veterinary Director, Dogs Trust. Held by RVC.
j. Cappello, R. & Rusbridge, C. Report from the Chiari-Like Malformation and Syringomyelia Working Group round table. 2007. Veterinary Surgery 36, 509-512 DOI:10.1111/j.1532-950X.2007.00298.x/pdf
k. Effectiveness of breeding guidelines for reducing the prevalence of syringomyelia. Knowler, SP, McFadyen, AK, Rusbridge, C. Veterinary Record. 2011;169:681 DOI:10.1136/vr.100062
l. http://www.thekennelclub.org.uk/health/health-information-and-resources/health-schemes-and-programmes/bvakc-health-schemes/bvakc-chiari-malformationsyringomyelia-scheme/ [accessed 13 Nov 2013]
m. Press reports on lack of appreciation of BOAS by dog owners
http://mydogmagazine.com/dog-health/owners-of-short-nosed-dog-breeds-unaware-of-health-defects/ [accessed 6 Mar 2012]
http://phys.org/news/2012-05-short-nosed-dog-owners-pets-problems.html [accessed 6 Mar 2013]