Canine tail injuries in New Zealand: Causes, treatments and risk factors and the prophylactic justification for canine tail docking.

A thesis presented in partial fulfilment of the requirements for the degree of

Master of Veterinary Studies

Institute of Veterinary, Animal and Biomedical Sciences

Massey University

Palmerston North, New Zealand

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2013

Acknowledgements

Thanks to supervisors Kate Hill, Daan Vink and Kevin Stafford.

I would like to thank Vivienne Lintott and Iain Gordon of Provet for writing the SQL script that made data collection on this scale possible, for providing detailed instructions for clinic staff, and for your always cheerful and swift responses to my various queries. A big thanks to the veterinary clinics that allowed me access to the information I needed to complete this thesis, particularly the VisionVPM pros more often than not found at reception.

Thank you to the New Zealand Veterinary Association's Companion Animal Society for their support and input into the original idea for this research thesis.

Thanks also to Mrs Berys Clark for the financial assistance provided to me through the Lovell and Berys Clark scholarships I received in 2011 and 2012.

To my partner Oskar, who I somehow found the time to "civilly unite with" during this year, thank you for your support over the past two years and of course, every year before that, and for the many to come.

To my own dogs, Bowser and Nikki - who probably take their own tails for granted - I have appreciated your wagging tails whenever I have needed cheering up and am glad nobody saw fit to remove them before I adopted you.

Abstract

Tail docking of dogs is often justified on the basis that it prevents tail injury, particularly in working and hunting dogs. However, little data exists on canine tail injuries in New Zealand.

Retrospective data from eight years' worth of records was collected from the clinical databases of 16 veterinary practices. A keyword search "tail" was run, and the results filtered manually to find all canine cases of tail injuries. 0.9% (n=619) of all dogs seen by the vet clinics over the study period suffered a tail injury. The most common given causes were accidents (13.3%, n=83), half of these (6.7% n=41) from a door shutting on the tail. The second most common causes were vehicle related, for example being hit by or falling out of a car or utility vehicle (10.0%, n=62).

Over half (51%, n=318) of the injuries were resolved by treatment with medication and over three quarters (77.7%, n=484) required a single vet visit. Only 13.8% (n=86) of tail injuries led to amputation.

Non-docked breeds are assumed to have intact tails. There was a significant association (P=0.003, Cochran-Mantel-Haenszel Chi-squared test) between tail injury and not belonging to a docked breed. The odds ratio for belonging to non-docked breed was 6.15 (95% CI 5.83, 6.50) meaning a non-docked dog was at least six times more likely to injure their tail as a docked breed dog.

Only 15.4% (n=96) of tail injuries occurred in traditionally docked breeds, but, the most common cause of injury within that group was docking itself (21.9%, n=21).

Labradors, the most popular pedigree pet breed, injured themselves more often (1.4%, n=100) than the most popular hunting (pig dogs, 1.3%, n=23) and farming (Huntaway, 1.0%, n=60) breeds.

It appears that tail injury is rarely observed usually easily treated. Tail docking puppies seems a severe method of preventing such injuries when only 13.8% had injuries or 0.12% of dogs visiting vet clinics require tail amputation.

This study used a novel data mining technique with a specially written SQL script to search the clinical databases of the clinics. This made the process more efficient, and data was reasonably complete. The clinic software is used widely in vet clinics in New Zealand, so this technique could be used for similar epidemiological research in future.

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Chapter 1: Introduction – The relationship between tail docking and tail injury

Proponents of canine tail docking (The New Zealand Council of Docked Breeds) argue that the procedure prevents tail injuries and thus spares a dog the potential pain and trauma of the injury itself, or amputation and other therapies as an adult. Such injuries are thought to be particularly problematic in farming and working dogs.

Docking has its own welfare implications. As well as being presumably painful, potential complications include infection, necrosis, blood loss and on-going trauma. Tail docking may also hinder an animal's ability to defecate, communicate and balance. The New Zealand Veterinary Association opposes docking for cosmetic purposes and only supports tail docking for medical or surgical reasons, not prophylaxis.

The actual incidence and severity of tail injuries in New Zealand must be assessed first for the prophylactic justification of tail docking to be infallible. This thesis investigated the causes of tail injury in dogs in New Zealand to examine whether working and farming dogs were more predisposed to tail injuries, and to explore other causes of injury, such as accidents involving vehicles, doors, attacks and exercise. Docking itself was also investigated as a potential cause of injury, as any injuries caused by docking will reduce the net gain of prevented injuries. Prior to this study there were no such valid statistics available on canine tail injuries in New Zealand.

The Code of Welfare for Dogs was amended in 2011, and an unprecedented number of submissions on this subject showed that it is still an emotive issue for people on both pro- and anti-docking sides of the argument. Tail docking is regulated by the Code and future drafts may ban tail docking if scientific evidence can support this. It is hoped that this thesis can determine whether or not canine tail docking is justified in order to prevent injury.

A literature review (Chapter 2) explores the way that tail injury influences the tail docking argument, in dogs and in other animals. A second literature review chapter discusses the data-mining methodology employed in this study. The main body of work is prefaced with a small pilot study of two clinics which enabled the development of an improved novel methodology for mining veterinary databases to collect information on tail injuries. This method has the potential to be used in future veterinary research.

Chapter 2: Literature review -Tail injury and the justification for docking in dogs and other species

Tail injuries in canines

Dogs suffer tail injuries from a variety of causes, including attacks, during work or exercise, from having their tail caught in a gate or door (Diesel et al. 2010), and even from docking (Wansbrough 1996). Injuries can affect the skin, bone, musculature or a combination of these.

The tail is an extension of the back bone, but the spinal cord ends before the first coccygeal vertebrae. The canine tail contains between 6 and 23 vertebrae (Wansbrough 1996). These are highly mobile, particularly at the tip, due to their vascularised musculature. The lateral and medial dorsal sacrococcygeal muscles are levitators of the tails, while the ventral sacrococcygeal muscles and illiocaudal muscle are depressors. Intertransverse muscles of the tail and coccygeal muscles are used to draw the tail sideways. The dorsal muscles of the tail are direct continuations of the muscles of the trunk. During defecation, firstly the tail is lifted and then the coccygeal, levator ani, and the rectococcygeus muscles relax. This tail movement is therefore quite essential in defecation, in particular enabling the very last of the faecal matter in a bowel motion to be passed.

The coccygeal nerves exit the spinal canal and anastamose to form the coccygeal trunks which cover the left/right/dorsal and anterior surfaces of the tail vertebrae (Wansbrough 1996). Between 4 to 7 paired coccygeal nerves serve the tail (Wansbrough 1996). Other nerves associated with the ischiorectal fossa include the pudendal, caudal rectal, superficial and perianal nerves (Budras, et al. 2007). The main arteries in this area are the internal pudendal artery, the ventral perennial artery and the caudal rectal artery (Budras, et al. 2007). The coccygeal nerves as well as the coccygeal vein and arteries extend into the length of the tail and must be severed during the tail docking procedure (Tobias 2010). The lateral caudal vessels are bilateral and are located in the subcutaneous tissue of the tail (Fossum 2013).

Injuries to the tail are presumably painful, but the degree of pain will depend largely on the nature of the injury.

Treatment of tail injury can also vary widely, with amputation or even euthanasia being the most severe. For a minor strain or swelling, treatment may include analgesic/anti-inflammatory drugs, or for some cases, merely rest. Where the skin has broken, topical treatments and antibiotics may be used, and sutures and bandaging may also prove necessary. A broken bone in the tail would be the most difficult to treat and if not able to heal could potentially result in amputation.

A major complication of tail injury is an inability to heal due to repeated bumping and knocking of the area (Diesel et al. 2010). Repeated aggravation of a wound may lead to amputation where the original injury would not have warranted it. Infection, necrosis, dehiscence, scarring, fistula recurrence, anal sphincter and rectal trauma can also be complications of amputation (Fosum 2013).

Tail docking is one method of preventing or minimising the risk of such injuries in dogs, but this practise is usually only applied to specific breeds, either because of their traditional use or tail conformation. There is very little in the veterinary literature that explores the issue of canine tail injury outside the context of justification for tail docking. There are few studies worldwide (e.g. Darke *et al.* 1985; Strejffert, 1989; Diesel *et al.* 2010), and none in New Zealand that have collected data on the nature, treatments and causes of tail injury in dogs.

Conditions that could be mistaken for tail injury

Those studies that investigate tail injury have demonstrated that it is reasonably rare (Diesel *et al*. 2010; Wansbrough 1996) but the perception remains that it is common enough to warrant tail docking. A number of other conditions described below affect the tail and hindquarters of the dog and may initially be misdiagnosed as tail injuries. These may be contributing to an overestimation of the number of tail injuries that actually occur. Whilst some of conditions may also be prevented by tail docking, these are not usually the type of traumatic injury that this study and others have investigated as a justification for tail docking. Any researcher observing tail injuries in dogs needs to be familiar with the following conditions.

Cauda equine syndrome

The cauda equina is made up of the last three lumbar vertebrae, the sacrum, the coccygeal vertebrae (Miller *et al*. 1967) and associated nerves. When this area becomes compressed, displaced or otherwise altered, the resulting neurological condition is known as Cauda Equina syndrome (Berzon and Dueland 1979). Depending on where the lesion occurs, it can result in pain in the back, tail and lower limbs, partial or total paralysis of the tail, and severe pain upon movement of the tail. Therefore the condition may initially present as, and be incorrectly diagnosed as tail injury. Other forms of arthritis affecting the hind limb may also have similar symptoms.

Limber tail

Limber tail is a condition that goes by many names including "cold water tail", "frozen tail", "dead tail", "rudder tail", "broken wag", or "flaccid tail syndrome". Thought to be caused by exertion, cold water or cold weather, limber tail appears as a flaccid, droopy tail that gives the impression of being broken (Steiss *et al.*1999). The condition is most often seen in working breeds, resolves after a few weeks and can be aided by rest, a warm compress on the tail and anti-inflammatory medication (Steiss *et al.*1999). Limber tail may possibly be prevented by docking, but is not treated by amputation. Cases of limber tail were not considered a traumatic injury case in the Diesel *et al.* (2010) paper.

Anal problems

Chronic constipation and full or infected anal glands may also have similar symptoms, with behavioural indicators of non-specific pain and discomfort in the hind quarters. As mentioned, the muscles of the tail are used in defecation and injury to some areas of the tail can actually cause constipation (Wansbrough 1996).

The interrelatedness of these two conditions could conceivably result in some misdiagnoses.

Tail docking in dogs and other species

Proponents of tail docking suggest it has the potential to reduce the incidence and seriousness of tail injuries in dogs, but docking has its own welfare implications. Despite a lack of scientific evidence categorically demonstrating that the practice as painful, tail docking in dogs is now banned or restricted in a number of countries; including the UK since 2007 (Diesel et al. 2010), Sweden since 1989 (Strejffert 1992), and Australia since 2004 (Harris 2004). In some cases, it has been argued that a tail docking ban results in higher incidence of tail injuries (Strejffert 1992). To make an assessment about which is more detrimental to animal welfare, tail docking or tail injury, we need to explore the evidence for each.

The practice of removing a dog's tail, usually shortly after birth, is customary in some breeds and up until recent bans, a docked tail was part of the breed standard for many common dog breeds such as spaniels, rottweilers and boxers. The practise is also common in other animals such sheep, pigs and dairy cattle.

Tail docking in New Zealand is regulated by Codes of Welfare that form part of the Animal Welfare Act 1999. The first code to contain recommendations for tail docking was the Code of Welfare for Painful Husbandry Procedures (Anon/NAWAC 2005) which deals specifically with tail docking of dairy cattle and sheep. The Code of Welfare for Pigs (Anon/NAWAC 2010a) and The Code of Welfare for Dogs (Anon/NAWAC 2010b) deal with this issue in these two species.

In horses, tail docking is a restricted surgical procedure under the Animal Welfare Act 1999. It can only be performed by veterinarians, and best practise is to refuse such surgery unless it is results in demonstrable welfare benefits for the horse (Anon/New Zealand Veterinary Council 2011). Therefore justification is made on a case by case basis by veterinarians and as such tail docking of horses is considered outside the scope of this review.

This chapter will review the practice in several animal species, including the procedure, justification and costs of tail docking to the animal.

Procedure

Tail docking involves the separation of muscle, bone, nerves, tendons and cartilage (Quartarone et al. 2012). This can be achieved by placement of a rubber ring or elastic band on the tail until it falls off, or cutting the tail off using a scalpel (surgical removal), scissors or hot iron. Typically this occurs in very young animals, and no pain relief is given (Sutherland and Tucker 2011). Because of the variations in their physiology, the procedure differs in each of the four species discussed in this review, and each has specific recommendations under New Zealand law for tail docking, in particular, the age by which the procedure must be performed.

In sheep a clamp may be applied prior to docking which restricts the nerves and helps to alleviate some of the pain of tail docking (Graham et al. 1997; Kent, et al. 1998). The age at which sheep are tail docked varies between countries but is usually performed before 8 weeks. In the UK, most sheep are docked in their first week of life (French et al. 1992), but in the US almost 20% are docked after 22 days (Anon/USDA 2003). The age at tail docking also varies according to farming system, with farmers in open-range systems tending toward docking later than farmers in confinement systems (Anon/USDA 2003). In New Zealand, The Code of Welfare for Painful Husbandry Procedures (Anon/NAWAC 2005) specifies no age limit in sheep.

In piglets, tail docking can be performed using teeth clippers, cutting pliers, a cutting blade or a cautery iron (Sutherland and Tucker 2011). According to the relevant Code, between one third and one half of the tail can be removed (Anon/NAWAZC 2010a). This is similar to the recommendations of Canadian Code of Practice (Anon, Canadian Federation of Humane Societies 1993) which suggest removing one third of the tail, but differs from UK which specifies that 2 cm should remain (Sutherland and Tucker 2011). The American Veterinary Association has no specific recommendation, but commonly the remaining part of the tail will be long enough to cover the vulva in female pigs and the equivalent length in males (Sutherland and Tucker 2011). After seven days of age tail docking may only be performed by a veterinarian.

In dairy cattle (but no other bovines) the Code for Painful Husbandry Procedures recommends only the removal of the last two or three vertebrae of the switch of the tail. This should be performed using a rubber ring, so that the tail is allowed to drop off. The tail may only be cut off if it has not dropped after seven days and this must occur below the point at which the rubber band is attached. Pain relief is not required or recommended for dairy cattle under the 2005 Code.

Tail docking of puppies can be performed two ways. The first involves clipping the hair from around the tail and clamping it with a rubber band, severing the tail with a scalpel or scissors, then stitching and bandaging the wound (Quartarone *et al.* 2012). This method is only available to veterinarians in New Zealand. In the second method, the application of a tight band ligates the blood supply to the tail and causes vascular necrosis of the soft tissues (Anon/ New Zealand Council of Docked Breeds 2013). The tail falls off after about three days. The application of the band usually occurs on the evening of the second day of the puppy's life (Anon/ New Zealand Council of Docked Breeds) to allow the tail docking to be completed by the time the dog is four days old. This procedure takes longer than the surgical method of tail docking but the tail does not bleed with this method. Anaesthetics are not usually available to non-vets (Bennett and Perini 2003) so are not usually used during tail docking.

The length of the remaining tail varies considerably between breeds, and of course many breeds and presumably most crossbreeds are not docked at all. There are no specific guidelines under the Code of Welfare for Dogs pertaining to tail length (Anon/NAWAC 2010).

The age at which dogs must be docked under New Zealand codes is the youngest of all animals at only four days, and the eyes must still be closed at this time. The New Zealand Council of Docked Breeds runs an accreditation scheme to ensure that banders performing the non-surgical method are competent.

Tail docking in dogs appears to be much more stringently regulated than the same in production animals, which may be a reflection of how contentious an issue this procedure is in canines.

Pain in young animals

Early work using electroencephalography suggested that neurologically immature altricial neonates do not experience significant pain before several days of age (Ellington and Rose 1970). Other studies (Yates, *et al*., 1976) suggested that a higher proportion of unmyelinated nerves in a neonate demonstrated that the nervous systems of new-borns were immature, and that nerve impulses are less intense in new-born animals. It is still thought that animals do not experience consciousness, and therefore pain, prior to electroencephalographic differentiation between rapid eye movement (REM) and non-REM sleep (Diesch, et al. 2009). This appears to first occur in puppies (depending on breed) at 4 -14 days old (Ellingson and Rose 1970, Mellor et al. 2009). The four day time limit on tail docking prescribed by the Code of Welfare for Dogs can be defended based on this evidence.

Wansbrough (1996) and Mathews (2005) refute the contention that neonates do not experience pain, and even suggest that the immature physiology of the neonate means that their experience of pain could actually be more severe than that of an adult. Neonates have a greater density of sensitised cutaneous nociceptors and inhibitory pain pathways may be yet underdeveloped in young animals. Furthermore, early painful experiences have been associated with increased sensitivity and anxiety during future painful experiences in humans (Taddio, et al. 1997) laboratory altricial animals (Lee 2002) and lambs (McCraken et al. 2010) so it seems reasonable to conclude the same could be true of other production animals and of canines (Mathews 2005).

Even if we accept that neonates experience pain, anaesthetics or analgesics are rarely administered to young animals, because of an oft cited risk of overdose due to decreased drug metabolism in neonates (Mathews 2005). It has been demonstrated that in such animals, morphine may cause ventilatory depression at smaller doses than those required to have an analgesic affect (Luks *et al.*, 1997), but there are suggestions in the same study and others (Bragg *et al*. 1995; Luks *et al*. 1997) that Fenatyl could possibly be an effective analgesic in neonatal dogs when administered gradually and with ventilation monitoring.

The behavioural and physiological responses of animals to tail docking have been widely studied in production animals to assess the level of pain experienced. Such studies have to be carried out carefully to account for confounding variables such as changes due to the stress of handling and taking samples.

In lambs, head turning, rolling, changing position and other types of restlessness are common behavioural responses to surgical tail docking (Graham et al. 1997; Kent et al. 1998; Grant 2004). The response to pain, particularly with surgical docking, is thought to be short term. Head turning, rolling, changing position and other types of restlessness are behavioural responses to this (Graham et al. 1997; Kent et al. 1998; Grant 2004). Lambs docked using the rubber ring method are more likely to display restlessness in the hours after the ring is applied, whereas lambs docked with a knife spend more time in abnormal postures and react to the pain almost immediately (Lester et al. 1996). However, sheep are the only animal in the (Painful

Husbandry Procedures) Code for which pain relief during tail docking is recommended, but only when docked after 6 months of age (Anon/NAWAC 2005).

In pigs, cortisol levels are similar in docked and control handled piglets at 1 or 6 days of age (Prunier et al. 2005, Sutherland et al. 2008). Behavioural responses to tail docking include tail jamming, wagging (Noonan et al. 1996) posterior scooting (Sutherland et al. 2008), increased vocalisation and higher vocal frequencies (Marchant-Forde et al. 2009) which could be indicative of pain.

Cattle show limited behavioural or physiological indicators of pain when tail docked. Eicher and Dailey (2002) note increases in tail grooming, restlessness and head turning upon application of the rubber ring, while others (Schreiner and Ruegg 2002) found no differences in behaviour. The latter study also found no changes to heart and respiration rates as a result of docking. Petrie et al. (1996) found elevated cortisol levels in hot-iron docked cattle given an epidural, which suggests that handling or some other parameter apart from pain could cause this difference.

A substantial body of knowledge exists on the species-specific physiological and behavioural responses of farm animals to tail docking, but it is hard to know how much of this can be extrapolated to puppies.

Calves and lambs are precocial young and the procedure is performed when the animal is a number of weeks old; therefore their experiences of pain could be potentially significantly different to those of four day old puppies (Bennett and Perini 2003). Though it is hard to know for sure just how painful the experience of tail docking is, much of the literature agrees that tail docking does indeed cause some pain. The inclusion of tail docking in the Painful Husbandry Procedures Code of Welfare suggests it is a procedure likely to cause pain, at least in the case of dairy cattle and sheep. Studies observe that puppies of tail docking age do shriek and whimper in response to the process of tail docking (Noonan, et al. 1996) which suggests they are experiencing pain, even if short-lived.

In New Zealand, the issue of docking in dogs was reviewed by the National Animal Welfare Advisory Committee (NAWAC) in 2010, but not banned due to a lack of evidence that tail docking puppies within 72 hours caused significant pain (O'Hara 2009).

Costs to the animal

Besides acute pain during tail docking, having a tail removed could result in other costs to the animal. The tail is used to varying degrees throughout many species for hygiene, communication, and balance, so to lose it could be detrimental to the animal's welfare.

Sheep can use their intact tails to flick at flies about their hindquarters preventing them from landing but their ability to do so with docked tails may be limited. The removal of the tail also prevents the dairy cow from swatting away flies on her own. Flies can be an annoyance to cows and this can cause economic liabilities when a cow's attempts to avoid flies disrupt eating behaviour and increases energy expenditure (Eicher, and Dailey 2002).

In dogs, the tail has functions in communication and balance, as well as acting like a rudder when the dog is swimming (Hickman 1979). Versatile attachment to the trunk is required so that the tail can carry out these important functions (Wansbrough 1996). The tail can communicate mood, status and intent through movement, position and size (Fox 1969; Bradshaw and Nott 1995; Leaver and Reimchen 2008). A loose relaxed wag of the tail (and often the whole rump) communicates general ease and friendliness, whereas a more subdued, low wag appears to be a gesture of appeasement. Dominance or aggression can be expressed with the tail held high, and wagged stiffly. A dog will firmly place its tail between its legs in situations of fear and submission. Quaranta et al. (2007) demonstrated that the direction of the tail, (left vs. right) can also communicate motivational state. Both human beings and conspecifics use the tail to read canine behaviour. Using a model dog with adjustable tail length Leaver and Reimchen (2008) demonstrated that this ability is impaired in a shorter tail. Without this appendage to broadcast the emotional state of a docked dog, other dogs may misinterpret their behaviour, or the docked dog may escalate to other, more direct tactics to demonstrate their feelings. This may leave them more prone to involvement in aggressive interactions. Further research on the relationship between tail length and aggression is warranted.

Risks of tail docking surgery

The procedure of tail docking itself can lead to infection, necrosis and other complications. As the spinal cord extends into the vertebral column, infection can even spread to the central nervous system in neonatal animals (Morton 1992).
In cases of surgical docking the risk of shock and blood loss (Bennett and Perini 2003) is a legitimate concern in neonates because of their small size, as any blood lost represents a significantly larger proportion of total blood. The risk of blood loss is however removed with banding.

The muscles involved in the tail are associated with the spine, pelvis and anus, and issues with these muscles can therefore be linked to urinary and faecal incontinence (Wansbrough 1996).Wansbrough (1996) suggests that removal of the tail in an adult dog (for example after injury) could lead to incontinence and related issues as a result of wastage and detachment of closely associated muscles. Prevention of this could be considered a good reason to remove the tail as a puppy; however the risk in this case is that the relevant muscles may fail to develop correctly (Canfield 1986). This may predispose docked dogs to other significant problems such perineal hernia (Ettinger 1989), where the contents of the pelvis herniate at the anal sphincter.

An association is thought to exist between tail docking and sphincter mechanism incompetence which causes urinary incontinence (Arnold et al. 1989; Holt and Thrusfield 1993). The levator ani and coccygeus muscles that attach to the tail are the equivalent to the pelvic floor muscles in human beings (Wansbrough 1996) and damage to these has been implicated in the risk of developing incontinence in human females after labour (Smith, 1989).

(Simonsen et al. 1991) suggest that neuromas can develop at the site of docking in pigs due to the abnormal growth of the severed nerves. This is assumed to cause increased sensitivity or chronic pain. Amputation neuromas can form at the site of docking in dogs. Here, the skin of the dog becomes lichenified and hyperpigmented, and due to repeated self-trauma becomes adhered to the tissue below (Gross and Carr 1990). Neuromas are incredibly sensitive and even mild pressure elicits an extremely strong behavioural response (Gross and Carr 1990). There is no inflammation in the area, but a proliferation of small nerve bundles is thought to be responsible for this pain (Gross and Carr 1990). Often neuromas resolve after an initial period of several weeks, though they can persist indefinitely (Bennett and Perini 2003).

Justifications for tail docking

Any procedure which irrevocably alters an animal, or causes acute or chronic pain, or poses significant risk needs to be demonstrated as necessary in order to be justified. Justification for tail docking varies between species but is often used as an animal management practice, particularly in the maintenance of health and hygiene.

Tail docking justifications can be divided into three categories:

1) Therapeutic: the tail is removed to treat an existing medical condition.
2) Non-therapeutic (or cosmetic): docking so an animal conforms to an aesthetic or breed standard
3) Prophylactic: The tail is removed to reduce the risk of future disease or injury.

In sheep, tail docking is primarily prophylactic: it is thought to maintain hygiene of the tail and anus area, to prevent dags, maintain hindquarter cleanliness and therefore reduce fly-strike. Despite its widespread use, there is very little scientific evidence of these benefits (Sutherland and Tucker 2011). Five of seven farms studied by French *et al.* (1992) saw a reduction in fly strike when docked animals were compared with non-docked controls but dagginess was reduced in only one farm so the relationship between this and fly-strike may not be direct. In addition, cases in this study were self-reported which may have led to some bias (Sutherland and Tucker 2011). Sheep can also undergo a procedure known as ultra-short docking, which is either a cosmetic/non-therapeutic procedure performed on show sheep to create the illusion of a more muscular hindquarter (Goodwin *et al*. 2007) or for ease of shearing. It has been demonstrated that shearing time per sheep increases by about 20% in sheep with tails (Scobie, *et al*. 1999).

In pigs, tail docking is used to prevent tail biting, a behaviour particularly problematic in intensely farmed pigs. Tail biting can cause severe damage which can lead to infection and result in reduced weight gain and overall body weight (Sutherland, *et al.* 2008; Wallgren and Lindall 1996), and sometimes euthanasia (Sutherland and Tucker 2011). Tail biting behaviour is thought to be the result of boredom or frustration suffered by pigs housed intensively, and a number of studies demonstrate how environmental enrichment can be useful in reducing this. Tail docking appears to be reasonably effective in reducing tail biting in pigs, but does not deal with the underlying causes of tail biting. MPI of New Zealand recommend that other approaches, such as the provision of straw rooting materials and other enrichment are attempted before tail docking, but the Code of Welfare for pigs specifies that when docked by a non-vet, the procedure must occur 72 hours after birth (Anon/NAWAC 2010a), so the window for trying such alternatives is quite limited.

Docking of dairy cattle first became prominent in New Zealand (Tucker and Weary 2002). This was also intended to improve hygiene by reducing the spread of faecal debris, and thereby reduce mastitis and improve milk quality (Sutherland and Tucker 2011). However there is currently no published scientific evidence to support the contention that tail docking improves hygiene (Eicher and Dailey 2002; Schreiner and Ruegg 2002). The Code of Welfare for Painful Husbandry Procedures specifies that tail docking of cows can “improve comfort for milking personnel and enhance milking efficiency” (Anon/NAWAC 2005). Docking was also thought to prevent transmission of diseases such as Leptospirosis from cows to human beings, but it has been demonstrated that other, worker specific management practices had more of a beneficial impact on disease control than tail docking (Mackintosh *et al*. 1980).

The justification of tail docking for sheep and cows appears to be primarily non-therapeutic where it allows for ease of milking and shearing. With pigs, and in the case of preventing fly strike in sheep, the justification is prophylactic and intends to prevent injury or disease.

Tail docking in dogs could be performed for therapeutic, non-therapeutic and prophylactic reasons.

Therapeutic docking (amputation) in dogs

In order to make assessments about its justification in puppies, the procedure of tail docking at four days must be compared to tail amputation in the adult. In order to differentiate the two, throughout this thesis the term “docking” is used to refer to routine preventative removal of the tail in the neonate, and “amputation” to refer to a therapeutic procedure in an mature dog, but the terms are used interchangeably elsewhere.

The surgical procedure of docking is described by Tobias (2010). A u-shaped incision is made one or two centimetres distal to the point at which injury has occurred. The skin is then lifted from the underlying tissues, to expose the blood vessels, the coccygeal artery and vein. These must be ligated to temporarily reduce blood supply to this area. The site of amputation should be cranial enough that the wound can be closed without excessive tension on the suture area. For simplicity's sake, it is preferable to amputate the tail at the intervertebral disc (Dyce et al. 1996), but it is possible to transect the vertebrae mid-body using bone cutters. After amputation, blood vessels may be cauterized or ligated to halt bleeding. The wound is then closed with uninterrupted sutures which can be removed 10-14 days after surgery. It will often prove necessary to prevent the dog from accessing and traumatising the area, for example by using an Elizabethan collar. It is advisable to cover the tail in plastic tubing or a bottle in order to protect the tail from being hit on other objects and traumatised as it heals. However this must be done carefully as covering the tail this way may predispose the tail to necrosis (Remedios et al. 1996).

Complications include infection, dehiscence, scarring, fistula recurrence, anal sphincter and rectal trauma (Fosum 2013), as well as haemorrhage and necrosis (Tobias 2010). High amputations are at lower risk of dehiscence and necrosis because tissues here are highly vascularised (Tobias 2010). Remedios, et al. (1996) describe bacterial complications that arose as a result of the application of an epidural analgesia prior to tail amputation in a German shepherd.

There are a number of other conditions besides traumatic injury in the dog where full or partial amputation of the tail may also be recommended. Amputation neuroma can be caused by tail docking, but rather ironically, amputation is also a treatment option for this condition. Neoplasias occurring on the tail can also be treated with amputation (Fossum 2013). Tail amputation may form part of the treatment of perianal fistuals in dogs (Van Fe and Palminteri 1987) but is considered an archaic treatment option by some. Tail amputation and removal of extra skin is the usual treatment option for tail fold dermatitis in English Bulldogs (see below, Nuttal et al. 2009).

In cases of persistent tail chasing or self-trauma of the tail, amputation may aid healing but as with tail biting in pigs, is unlikely to alter the neurotic behaviour as it does not deal with the underlying condition (Landsberg, et al. 2003). Self-trauma can also occur in other parts of the body, such as the paws, where amputation would not be considered an option. Furthermore, any wound created by amputation may also aggravate the condition as the dog may continue to traumatise the area in response to pain and discomfort during healing.

As mentioned, amputation in the adult is preferable in a number of ways, including the option of using anaesthetic during the procedure, and analgesics to assist during recovery. However, one can see from a comparison of the two procedures that amputation is a much more precise and complex process than tail docking in the neonate and the former may only be performed by a qualified veterinarian. Therefore the surgery and any subsequent treatment during recovery may certainly prove more costly and time consuming.

Non-therapeutic Prophylactic tail docking

Preservation of tradition is often used as a justification for continuation of tail docking (Dyer 2004) particularly as in some breeds, docking is essential to conform to breed standards. In the United Kingdom during the 18^{th}Century, docking a dog's tail allowed the owner to avoid paying tax on non-working or 'luxury' dogs (O'Hara 2009). The hygiene around the anus and tail areas of some dog breeds was also managed by the docking of the tail (Anon/NAWAC, 2010), which would now be more commonly managed with careful clipping, grooming and bathing. Docking was thought to help dogs avoid injury while they carried out their purpose bred tasks of working or hunting (Dyer 2004), and this tradition may have led to the tailless aesthetic gaining favour.

Tail docking of dogs is thought to have begun around 1-2000 years ago (Bennett and Perini 2003; Dyer 2004). Given that dogs have been domesticated for about

15,000 years (Bennett and Perini 2003); tail docking is a relatively recent husbandry practice, so we would only be preserving more recent tradition. Breed standards date back to the nineteenth century and preserve the ideals of the time (Kane 2010), but conformation to these in other ways has been shown to have significant repercussions for canine welfare (McGreevy and Nicholas 1999; Rooney and Sargan 2010). Examples include the breathing troubles of the brachycephalic Bulldog, or syringomyelia suffered by Cavalier King Charles spaniels as a result of their juvenile rounded skull and prominent eyes favoured by breeders. The UK Kennel Club has shown some willingness to alter breed standards in light of such issues (Anon/UKKC 2007). In much the same way, breed standards have also been altered in response to the UK ban on tail docking, with "*previously* traditionally docked dogs" now labelled as such.

As there is no ban in New Zealand, the New Zealand Kennel Club has maintained a pro-choice stance, with both docked and non-docked specimens able to meet breed standards, and, in theory, become champion show dogs (Warman 2004). However, there is a perception that a tail docked dog is preferable or is a more authentic representative of the breed (Bennett and Perini 2003). On the other hand, one could suggest that the tail is an additional feature to be judged, and if at all flawed it will prove a disadvantage.

Tail docking proponents also argue that if breeders fail to tail dock their puppies, it may be difficult to find homes for them as they do not conform to the preconceived "ideal" or breed standard that potential owners have in their minds. Breeders show some concern that the animals would be abandoned or euthanized in such a case – presumably a worse fate than having their tail docked. A change in policy will influence attitudes and vice versa but until policy changes, breeders, kennel clubs and vets should educate potential owners about the changes to the law and breed standards in the UK, as the New Zealand Kennel Club is influenced by its mother organization in the United Kingdom. Vets should also promote their position that tail docking is not medically justified.

The preservation of tradition is a weak argument for tail docking, and offers no welfare benefit to the animal. Such traditions began at a time when the legal and moral position of animal was much lower than it is today (Bennett and Perini 2003). With new knowledge about animal welfare comes new obligation to treat animals humanely. It would be unfair to hold onto tradition at the detriment of animal welfare, and many are realising this. Bullfighting tradition was much part of the national identity of Spain (Mitchell 1991), and although the decision may have been more political than animal welfare based (Black 2010), a ban on bullfighting came into force in the region of Catalonia in January of 2012.

Confusion of non-therapeutic and prophylactic arguments

Members of the New Zealand Council of Docked Breeds (Anon/NZCDB 2013) are proponents of both non-therapeutic (adherence to tradition/breed standards) and prophylactic (prevention of injury) arguments for tail docking. However, mixing prophylactic tail docking justifications with cosmetic or tradition-based arguments weakens the argument for the former. The organization advocates a right to choose to dock, but *only* the tails of breeds that are traditionally docked according to their breed standard. Their website advocates “Freedom of Choice for all *Pedigree* dogs” and “preservation of our existing rights as guardians of our *selected breeds*”. The NZCDB does not appear to advocate for the docking of crossbreeds or non-traditionally tail docked breeds even though such animals can and do injure their tails.

Their argument, and that of the New Zealand Kennel Club according to their breed standards, appears to be that only certain breeds are predisposed to tail injury. This may due to conformation of the tail (for example, sparsely covered whip-like tails are presumably more fragile than thick ones) or traditional use of those breeds in hunting and farming (as opposed to actual use in the individual). There are inconsistencies with both of these assertions; not all whip-like tailed dogs are traditionally docked; consider the greyhound type. Similarly not all gundog and farming breeds are docked, e.g. the Labrador or Border collie. There are even examples of breeds which are both working dogs and are thin tailed, that are not traditionally docked, such as the English pointer. Whether or not a breed standard includes tail docking is so inconsistent that it appears to be influenced much more by tradition or aesthetic than any evidenced predisposition to injury.

This confusion of breed standard with traditional use means that many puppies may be docked unnecessarily. If the risk of injury comes from *actual* use in hunting or farming, then it makes no sense to base the decision to dock based on breed alone. However, there are problems predicting the future use of puppies and they must be docked within four days of being born (Anon, NAWAC 2010b). It is likely that breeders dock every puppy of traditionally tail docked litters as they cannot be docked later as demand for hunting or working dogs dictates.

If hunting and working dogs, as opposed to dogs used for any other purpose, are more likely to sustain tail injuries, then it is only those individuals that are actually regularly used for hunting or farm work that can benefit from tail docking. It would be necessary to assess the number of docked, gundog or working breed dogs that are actually regularly used for hunting or working activity before assuming that tail docking such breeds significantly impacts the prevalence or severity of tail injury. Presumably it is not justifiable to dock the tail of every puppy of a certain hunting breed when only a proportion will actually be used for that intended purpose.

Prophylactic Justification of Tail Docking

A submission by Dyer (2004) of Fish and Game NZ represents the interests of hunters and their dogs. Unlike the NZKC's stance, this argument is much more based on the actual use of the dog as a predisposition to injury. Dyer (2004) states that the majority of dogs used for hunting are not registered with the NZKC. It is likely that a very large proportion of these dogs are crossbred and therefore breed standards are irrelevant to them, meaning the arguments for breed standard and actual use can be separated. This allows the argument to move away from tradition, and allows the prevention of tail injury argument to stand alone.

The submission asserts that tail docking prevents terrain induced tail injury specifically among hunting dogs in New Zealand (Dyer 2004). In Denmark, tail docking is banned in all but five breeds of gundog (Lefebvre *et al.* 2007), so there appears to be some acceptance of the belief that gundogs in particular are prone to significant risk of tail injury. However there have been no studies which have compared the incidence of tail injury in docked and non-docked dogs of the same breed, or between undocked traditionally tail docked dogs and non-traditionally tail docked dogs.

The tail injury prevention argument posed by Dyer (2004) is a much better justification for tail docking than tradition, but there are still a number of assumptions made that need to be accepted in order for this argument to be valid.

Risk of tail injury is *significant enough* to warrant amputation to prevent it.

Past studies have demonstrated that tail injury in the general canine population is uncommon. A study of a vet clinic in Australia only saw three tail injuries in 2000 veterinary cases (Wansbrough 1996). Diesel *et al.* (2010) found that tail injury was so rare that 500 dogs would have to be tail docked in order to prevent one tail injury.

A docked tail forms part of the breed standard of 57 of the 184 breeds recognized by the NZKC (Warman 2004). Only three of the NZKC's top ten breeds, (Rottweilers, Boxers and Cavalier King Charles Spaniels) are tail docked (Anon/NZKC 2007), but 34% of the puppies registered by the NZKC annually belong to tail-docked breeds (Warman 2004). 10,200 new dogs were registered to NZKC in 2006 (Anon/NZKC 2007). This suggests about 3468 puppies' tails were docked that year, not including those that died before registration, a small number of imports docked when they were puppies, and as it is not compulsory, a small number not docked at all. Additional to the NZKC registered dogs are those used for hunting as the majority of these are not NZKC registered (Dyer 2004). Non-pedigree farming dogs and pets could also be docked but are presumably not a significant group. Rounding up to 4000 individuals and using the findings of Warman (2004) and Diesel *et al.* (2010), the docking of this number of dogs in one year in New Zealand can be expected to prevent between 6 and 8 tail injuries over the lifetimes of those dogs.

Risk of tail injury is significantly increased by activities such as hunting

According to a review by Lefebvre *et al.* (2007), paw and bodily injuries from the terrain are more common than tail injuries in hunting dogs. This could merely be due to the fact that those hunting dogs do not have tails, but also it reveals that other injuries which could not be prevented by prior removal of the relevant body part are also significant. Dyer (2004) suggests that hazardous terrain is the culprit likely to cause a hunting dog injury. However, the majority of hunting injuries actually occur during interaction with the hunted animal (Lefebvre *et al.*, 2007). Hunting is a dangerous activity which can result in a variety of bodily injuries, which may be a better argument for the cessation of hunting with dogs than the preservation of tail docking.

Though uncommon, tail injury is by no means restricted to working and hunting dogs. In fact, Diesel *et al.* (2010) found that only 17.5% of tail injuries occur “outdoors”, compared with 36% inside the home. A comparable number (14.4%) of dogs suffered tail injuries as a result of their tail being shut in a door, which could conceivably occur in almost any dog, with pet and indoor dogs presumably at a higher risk of such an injury. It must be remembered throughout that present statistics on tail injury may be a little inconclusive because of the low number of tail injuries overall.

If hunting activities increase the risk of tail injury to the point at which tail docking is justified, then all gundogs, regardless of their breed standard, should be consistently docked, but as has been discussed, this is not the case. Because tail injuries are rare anyway, all gundogs regardless of their breed standard or use need to be docked in order to prevent tail injuries in substantial numbers. If tail injury were breed-specific as breed standards for docking suggest, then gundogs belonging to non-docked breeds, or for that matter crossbreeds, which presumably have more robust tails be a more suitable choice for hunting activities.

Only hunting (and working) dogs can benefit from tail docking

Though some of the same arguments might apply to working dogs, the submission by Warman (2004) does not address the docking of non-hunting dogs. New Zealand’s most popular breed, the Labrador retriever (Anon/NZKC 2007), or various crossbreeds, may benefit from tail docking, as they are numerous and their popularity as pets and presumably indoor dogs may predispose them to having their tails shut in a door. Yet no one makes this argument that the tails of these dogs need to be docked to prevent injury.

This is important, as under this argument, only working dogs are protected from tail injury by having their tails docked. As has been demonstrated from limited tail injury statistics, this is not true; dogs of all breeds are susceptible to injury and if docking prevents injury, a number of traditionally undocked dogs might also benefit from tail docking. Consider the case of the English bulldog. Among a raft of other health issues, a number of Bulldogs suffer from tail fold dermatitis when the short, curly tail becomes inserted into a pocket of skin at the base of the tail. Friction and pressure in this area results in the breakdown and subsequent infection of skin (Nuttal et al. 2009). It can be difficult to keep the tail clean and dry. Surgical amputation in the adult is one method of treating this condition (Nuttal et al. 2009). Despite this problem, it is not argued that the English bulldog become a docked breed. If docking exists for prophylactic health reasons, then this is a good a reason as any to tail dock for prevention of injury and adult amputation.

Tail docking in puppies is less severe than tail injuries or amputation in the adult

Dyer (2004) attests that pain and injury resulting from docking is less prevalent or less severe than potential tail injury or amputation in the adult. “Stitches, therapy and full amputation” are mentioned but given the low incidence of tail injuries, the total combined pain and injury prevented by tail docking might not be as substantial as that which it causes. Whilst some may believe that a puppy’s experience of pain is lesser than an adults or even non-existent, the risk of tail injury, especially injuries severe enough to warrant amputation, needs to be significant enough to justify even minimal pain in such a large number of puppies. Additionally, tail amputation, where necessary, would be preferable in the adult in many cases, because it can take place under anaesthetic, although the use of this comes with its own risks. Additionally adult dogs can be given pre-operative analgesics or on-going pain relief after the procedure while they are healing.

Tail docking *prevents* injury and doesn’t *cause* it.

It seems logical that it is more difficult to injure a tail that either takes up less physical space or virtually doesn’t exist, but no study has comprehensively demonstrated this to be true by comparing the incidence of tail injury in docked and undocked dogs of the same breed. A report to the Swedish German Pointer club by Strejffert (1992) suggests that the number of reported tail injuries increases when tail docking is banned. The findings of such studies are confounded by the fact that docked dogs sustain fewer tail injuries merely because they have no tail to injure. In addition, this study concerned only one breed, and did not make statistical comparisons between docked/undocked dogs before/after the ban. Perhaps also, dog owners are more likely to report a tail injury when a ban has just been put into place. Strejffert’s (1992) findings were never published in any peer reviewed publication, so their conclusions must be interpreted with caution. Other studies suggest that tail injuries are just as common in docked as undocked dogs (Darke *et al.* 1985).

As described above, tail docking poses its own risks of bacterial infection, blood loss, shock, necrosis and other complications. The three tail injuries out of 2000 seen by the aforementioned Australian (Wansbrough 1996) study were problems directly associated with docking, so were actually caused, not prevented by tail docking. Tail docking to prevent injury can only be justified if it prevents more frequent and/or severe injuries than it is known to cause.

It may appear as though tail injury is less common in traditionally docked dogs, but this is likely because a dog cannot injure a tail that does not exist, or is less likely to injure a tail which is smaller and occupies less physical space. However, tail docking is not without its own risks, is inconsistently applied, and reduces the risk of an injury that is already comparatively rare.

Prevention of tail injury, is perhaps the most compelling justification for tail docking, the as it has the potential for welfare benefits for the individual animal, which could outweigh the welfare costs of docking. It is this justification that the current study aims to address. Despite the pain apparently cause by docking, in production animals there may be some justification for the practice in terms of ease of animal management. As yet there is no evidence to support the prophylactic justification of tail docking in dogs.

Other cosmetic procedures in dogs

This review has already discussed some of the issues concerning tail injury in dogs, and tail docking in a number of species. To place canine tail docking in context, it would be prudent to discuss some other non-therapeutic procedures in dogs. In their review of tail docking in production animals, Sutherland and Tucker (2011) refer to the procedure in dogs as purely “cosmetic” and many veterinarians would agree where it affords no measurable benefit to the animal. Other cosmetic procedures in dogs include ear cropping, de-vocalisation, and de-clawing. Like tail docking, ear-cropping formed part of the breed standard for approximately 17 dog breeds, including Great Danes, Dobermans, Schnauzers, Boxers, and Miniature Pinschers. Ear cropping also has its proponents that suggest that the procedure prevents injury, specifically ear canal infections, but there is no evidence that this is the case (Quartarone *et al.* 2012), so it may be reasonable to conclude that the real motives for ear cropping are tradition and aesthetics.

However, unlike tail docking, the procedure occurs when puppies are between six to twelve weeks of age (Jensen 1950; Leonard 1958; Hancock 1968) and therefore can be, but is not always, performed under anaesthetic. First the pinna is removed and then the ears are splinted in an upright position (Quartarone *et al.* 2012). Post-operative analgesic use is rare, and the ears, often handled and stretched in follow-up visits, are likely to bleed (Quartarone *et al.* 2012)

Unlike tail docking however, ear cropping was banned in New Zealand in 2004. It is an offence under Section 21(2)(a) of the Animal Welfare Act 1999 to crop, or cause to be cropped, the ears of a dog. In other countries, ear cropping and tail docking are treated the same way, and in the Czech Republic the performance of either procedure is considered an act of cruelty under the law (Quartarone *et al.* 2012)).

De-barking or devocalization involves the removal of the vocal chords in order to soften or silence a dog's bark. This is still legal in New Zealand under the Code of Welfare for dogs (Anon/NAWAC 2011) but only as a last resort when all other attempts to halt barking have failed. De-clawing of dogs is not covered by the Code, but like tail docking removal of the dew claw must be performed before the dog is four days old. However this procedure could be performed when the dog is under anaesthetic for other reasons, such as for de-sexing.

Conclusion

Tail injury in dogs is not often explored in research outside the context of tail docking as a preventative measure. Tail injuries appear to vary in their cause and nature, and can be painful, as well as difficult to treat and time-consuming to heal. However, tail injury appears to be quite rare and there are a number of conditions that could be initially mistaken for a tail injury.

Tail docking is already carried out on a range of species for ease of animal management and health and could be one way to prevent traumatic tail injury in dogs. Although it is not usually argued for, other, non-injurious conditions can also be treated by amputation and could therefore feasibly be prevented by tail docking. Tail docking is less complex than tail amputation later in life, and therefore less costly, time consuming and potentially less unpleasant for the animal, though anaesthetics and analgesics can be used in the latter procedure.

The law in New Zealand varies considerably in its treatment of tail docking depending on species. The regulations regarding dogs in particular seem to be stricter, and there are a number of other non-therapeutic or cosmetic procedures in dogs that are outright banned, thought to be unjustifiable.

The New Zealand Council of Docked Breeds demanded evidence that the procedure causes significant pain before they would consider a ban on tail docking acceptable (McIntyre 2005). Though behavioural and physiological responses to tail docking in a variety of species suggests that it is painful, pain is an intrinsically subjective experience, and it is impossible to know for sure whether another human or animal's experience of pain is comparable to one's own. Therefore, is might be more reasonable to place the "burden of proof" on tail docking proponents (Bennett and Perini, 2003), and demand evidence that tail docking is justified by a provision of significant benefit for the individual being docked. If no such benefits exist, then it would be ethically sound for us to err on the side of caution and assume that even with minimal pain, tail docking of dogs is unnecessary and therefore unjustified.

The prevention of injury argument appears to be the best justification for tail docking in dogs, and some proponents of tail docking insist that it will prevent tail injury later in life. Others suggest tail docking could be a substantial cause of tail injury. Currently, there have been no studies into the prevalence of tail injuries in dogs in New Zealand.

There is a need for this research into the relationship between tail docking and tail injury because docking is capable of both creating and preventing injury. The nature and prevalence of tail injuries in New Zealand needs to be examined more closely to better understand their welfare impact.

For this study, the hypothesis is that tail injuries will be reasonably rare in the New Zealand population. One would expect that only a small number of dogs within this group would require tail amputation as a result of their injuries.

If these two assumptions are correct then tail docking a dog for the purposes of preventing injury would not be justified. Similarly, if it is found that tail docking is in fact a significant cause of tail injury, this would also damage the prophylactic argument for tail docking.

The aim of this study is to establish the prevalence of tail injuries in New Zealand. A secondary aim of the study is to establish the causes, treatments and risk factors for these tail injuries. By fulfilling these aims, it would be easier to make evidence-based assessments about the suitability of tail docking as a measure of preventing injury in dogs.

It is expected traditionally tail docked dogs would suffer fewer injuries than other dogs, if only because a shortened tail occupies less physical space and is at a lower risk of becoming injured. It is not expected that there will be a difference between the number of males and females suffering tail injury, or that the age distribution at time of injury would be skewed in either direction.

It is expected that the causes of injury will be many and varied as suggested by the work by Diesel *et al.* (2010), including a significant number of tails damaged in doors. A higher number of injuries caused by hunting or working activity would be expected if Strejffert (1989) and Dyer (2004) are correct.

If the nature of tail injuries in New Zealand were better understood, interested parties will be in a better position to evaluate the practice of tail docking as justified during the next review of the Code of Welfare for Dogs. If a ban does come into place, the information gained in this research thesis can be compared with data gathered after a ban, to see if there is a change in the number and nature of tail injuries with more tails in the population to injure.

Chapter 3: Data mining and veterinary medicine: a review of the literature

Introduction

This study requires a large amount of data in order to perform meaningful statistical analysis, as other studies have demonstrated that tail injury is quite rare (Wansbrough 1996; Diesel et al. 2011). Database mining is the analysis of such large data sets in order to uncover hidden patterns or relationships (Hand et al. 2001). It has applications in marketing, banking, customer relations, engineering and many other areas of science. It has widely recognised benefits for healthcare (Li et al., 2011) and there were high hopes for its use in medicine, but the uptake of IT technology is so far quite limited in this field (Bellazzi and Zupan 2008). The knowledge gained from data mining is known as Knowledge Discovery through Databases (KDD) and can be used for diagnostics, evidence-based treatment and for research (Greenes and Shortlife 1990; Connelly and Alder 1997). Similarly, the approach has been underused in veterinary medicine, but its use is generally on the increase, particularly in research.

Much like medical records, veterinary client information is increasingly stored electronically, commonly on databases. This provides a large body of data with the potential to be used to obtain new knowledge (McDonald et al. 1999). However databases are only as useful as the information they contain. Staff may be poorly trained on how to use them and user errors such as incorrect spelling and missing fields can compromise the accuracy and relevance of search results. Some sections, particularly the clinical notes field can be free form text fields, which can result in very little consistency between veterinarians (Christopher and Hotz 2000). In addition, much of the software used by clinics is used for little more than inventory and printing out bills, as these, rather than research, were the functions that the software was originally developed for.

RxWorks (RxWorks inc., Las Vegas, NV, USA.) is one such veterinary database software program. This program, along with several others, was used by Diesel et al. in their 2010 study, and it used by researchers at the School of Veterinary and Biomedical Sciences at Murdoch University (Tangtulyangkul et al., 2009). It is usually necessary to involve IT technicians and/or developers in the research process in order to select the relevant data from the database, and present it in a user-friendly format (Tangtulyangkul et al., 2009). Many databases will contain a large amount of inaccurate, incomplete or incorrect data and manual evaluation and elimination of information is usually necessary before it can be mined (Christopher and Hotz, 2000). The spread sheet format allows researchers conversant in veterinary medicine, but not information technology, to carry out this manual processing.

Use of data mining software

Though the information is collected electronically, traditionally, the data cleaning and analysis stages of data mining are usually conducted manually (Li et al. 2011). However the amount of data collected in some cases necessitates the use of separate data mining software packages. The use of automated data mining software can reduce the impact of human error on the data set, the result of rather laborious and often tedious data cleaning (Li et al. 2011). Such errors can have very real consequences for the results. KNIME (University of Konstanz, Germany) RapidMiner (Technical University of Dortmund, North Rhine-Westphalia, Germany) and Tanagra (Ricco Rakotomalala Lyon, France) are free to use and open source examples of such automated data mining software. There is some argument for automating almost the entire process (Simunek and Rauch 2011) but the use of human experts with specialised knowledge is also important for catching outliers that exist as number on a spread sheet, but make no sense in real life (Li et al. 2011).

Information Overload

Data mining can often take place in the form of a keyword search. As Wang and Forgionne (2008) and Hochstotter and Koch (2009) point out, this can often result in information overload, so it is important to use techniques, either electronic or manual, that will filter out irrelevant matches.

Keyword searches depend on accurate and consistent data entry by those people using the database. If an entry contains a keyword, but that keyword is spelled incorrectly or is disrupted by a typographical error, then the entry will not be included in the results. Relational databases would usually be considered to contain quite structured data, but the use of free text fields can mean some unstructured or partially structured data is contained within.

Any data mining research that relies heavily on a free-text field is subject to additional problems in standardization. In the medical and veterinary fields, a professional's interpretation of symptoms, the use of ambiguous terms or statements, or the synonymous use of names and terms for diseases can make standardization very difficult (Cios and Moore 2002). In particular, any "clinical note" or "other" field will often be written up in a type of shorthand which may be unfamiliar to other physicians, let alone the researcher. Although automated text reading methods might seem tempting, it is sometimes necessary to use human beings that can read the full clinical notes and understand them in the appropriate context.

Privacy and ethics in data-mining

While many researchers recognize the valuable opportunities that data-mining presents, many are less willing to look the ethical privacy and confidentiality issues (van Wel and Royakkers 2004) inherent to data mining due to its use of personal information (Lawler and Mulluzo 2005).

Privacy is a complex legal concept – three working definitions of privacy are offered by Tavani (2004). "Accessibility privacy" is the right to be free from intrusion in physical space, whilst "decisional privacy" is the right to make one's own decisions and a defence against outside interference in personal matters. The final type, informational privacy, concerns the ability of an individual to control or restrict the flow of his or her personal information, so is of particular relevance in data mining. Information technology plays an important role in these techniques, and this present additional security concerns. The advent of the internet has made this sort of ethical discussion particularly relevant, but informational privacy and information security are not new concepts (Cooper and Collman 2005).

Customer, client or patient data is collected by governmental, private and commercial entities, and such information is often stored in data warehouses (Lawler and Molluzzo 2005). For commercial businesses, this data can be valuable in recognizing patterns in customer behaviour, and these patterns can be exploited in a way that profits the business. The targeted advertising of Google and Facebook is a particularly prominent online example. Both trawl the content viewed by their users (including those in private emails) in order to provide them with targeted advertising – often with inappropriate or offensive results.

When data mining is used by the medical field however, the consequences can be much more serious. Practitioners collect a wide range of data on their patients, from their date of birth, and ethnicity, to their family history, height, weight and of course, diagnoses. The patient-practitioner relationship means that trust is paramount. Patients have to feel safe disclosing all personal information in order to receive the best treatment, but such honesty is also important for the integrity of research (Cooper and Collman 2005). In New Zealand, the collection, storage and use of healthcare information is regulated by the Healthcare Privacy Code of 1994.

The pieces of data described above are considered "non-identifying", and deemed safe to use. Data is often compiled from several sources and then supplied to industry and researchers. When observed synergistically (for example, combining date of birth with ethnicity) such data can point to a mere handful of individuals (Cooper and Collman 2005). This is known as the “inference problem” (Farkas and Jajodia 2002). The very purpose of data-mining is to observe patterns in the data, but by doing so, privacy can be compromised.

Because veterinary medicine does not deal with human patients, it does not need to be as stringent in regards to its privacy regulations. However, the animal’s caregivers, human clients, do have some rights regarding the collection of information pertaining to themselves, and by extension their pet. Unlike medical data, information collected by veterinary clinics falls under The Privacy Act, 1993. Most significantly this gives clients the right to view and check for accuracy the information collected by such agencies. Veterinary clinics tend to use this information much like any commercial entity, for example in targeted marketing campaigns, but also for debt collection and sometimes, research. Some veterinary database software packages include functions which allow clinics to target special deals or push specific product to the correct clients, as well as send out reminders for vaccinations and other treatments which are nearly due.

In many ways the veterinary field is similar to the medical field in terms of the use of data-mining, but the matter of privacy, and therefore ethics, is considerably different.

Conclusion

Data mining in the form of a keyword search would be a good method to apply in researching tail injuries in New Zealand. Because injuries are thought to be comparatively rare, a high number of injury data needs to be collected in order to make any statistically robust conclusions, and this would method would provide this.

Some information overload and/or false positives are expected, and manual filtering of the data is likely to be necessary. Though it can be time-consuming and complex, it would not unfeasible for a study of this size and duration. There are both positive and negative aspects to using this type of methodology, but it is thought this will yield the appropriate information needed for this thesis.

By collecting data only on the animal subjects and not their human owners, some of the obstacles presented by privacy concerns are removed. This will put participating clinics at ease and is an ethical way of collecting information electronically.

Chapter 4: Pilot Study

Introduction

Tail injuries in dogs are thought to be rare, so mining of data from vet clinics may be a good method to apply in researching tail injuries in New Zealand. RxWorks and other veterinary clinic management software packages have been used for similar studies (Diesel *et al*. 2010). In the current study, the veterinary database program VisionVPM (Build 344.12, Provet, Castle Hills, Australia) has been utilized. In New Zealand VisionVPM is used by over 200 clinics, including several “branch” clinics that share a database. VisionVPM can run what are known as Marketing Searches, which were originally developed to allow clinics to identify target clients to promote services and special deals. For this pilot study the marketing search was modified. The aim of this pilot study was to determine if the VisionVPM software was appropriate for detailed data mining searches.

Method

Two clinics known to use VisionVPM as their main clinical records software were contacted to see if they would consent to their records being mined for this pilot study. Both clinics were branches of the same chain, and both were in suburbs of Wellington, New Zealand’s capital city.

On the main menu of VisionVPM the Clients module was selected, followed by Clients menu and finally Marketing Searches. In this menu “Insert” was selected and then the “Clinical” tab.

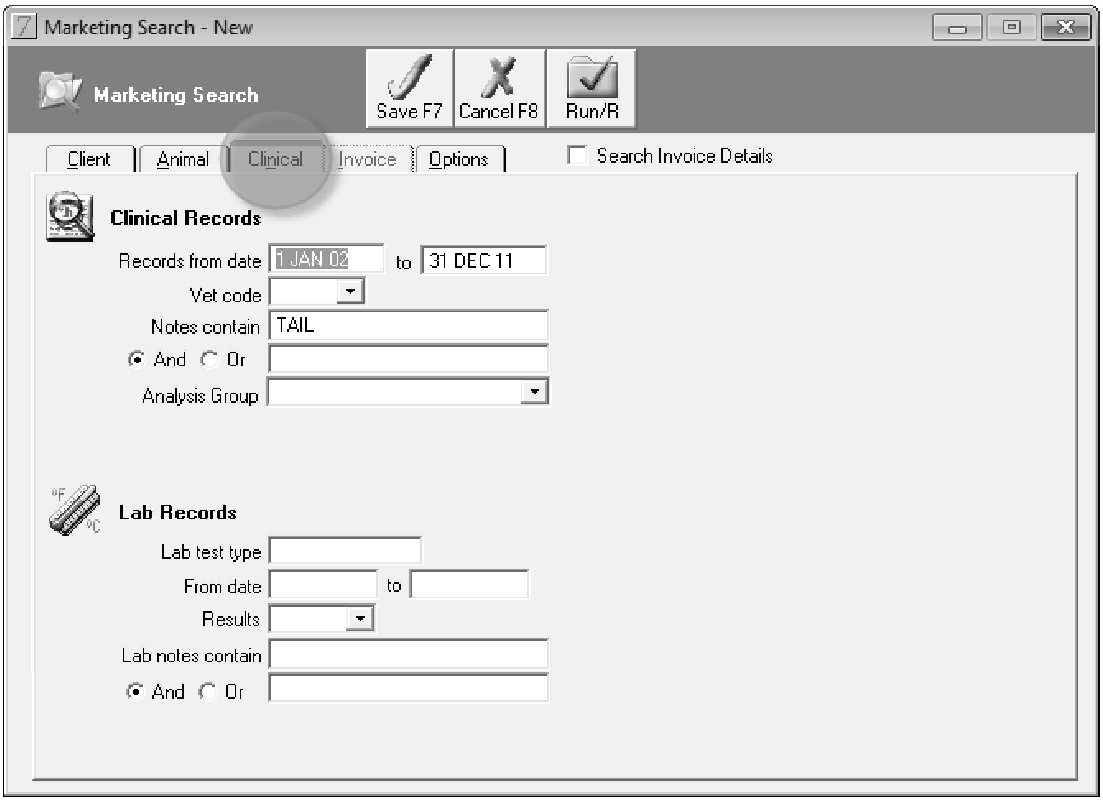

Figure 1: In the pilot study of two Wellington vet clinics, date range and keyword “tail” were specified on the “Clinical” tab in VisionVPM’s Marketing Search to search for dogs fitting these criteria (Screenshot courtesy of V.Lintott, Provet)

Both clinics had been using the system for over a decade, so the date range specified was between 01 Jan 2002 and December 31, 2011.

The keyword “tail” was entered in the “Notes contain” field. VisionVPM will search live animals of all species, so it was necessary to specify canine species and all inactivated patients on the “Animal” tab.

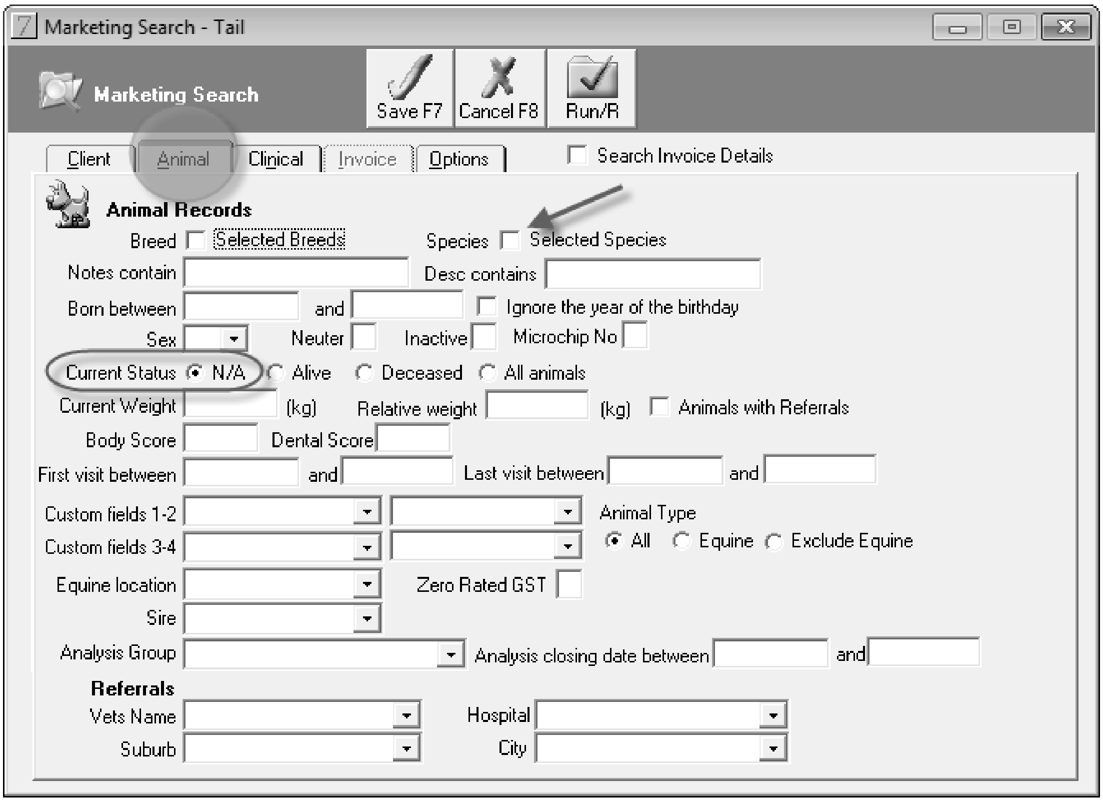

Figure 2: In a pilot study of two Wellington vet clinics, the “Animal” tab in VisionVPM’s Marketing Search enabled researchers to select species and current status (Screenshot courtesy of V.Lintott, Provet)

The search itself (rather than the results) was then saved and the search began when researchers selected “Run”.

The results of this search included any animals which had the word “tail” anywhere within the clinical notes of any past vet visit. To find which record in the animal’s history contained this search term, a second search for “tail” needed to be run by clicking “Search” under the “History Options” menu.

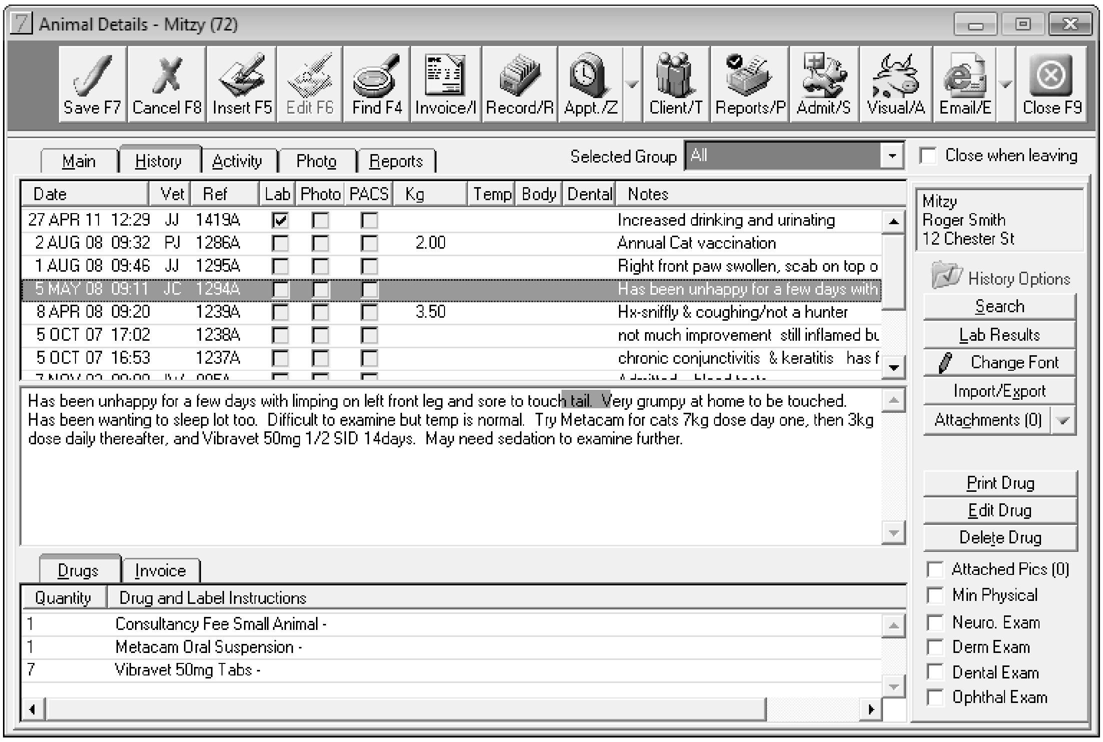

Figure 3: Example results page of VisionVPM's Market Search, showing history options tab which enables all clinical notes for an individual to be read. (Screenshot courtesy of V. Lintott, Provet)

Each set of clinical notes had to be read through manually, or, in the case of very long records (for example where a dog's clinical history had been transferred from another clinic), exported as a .txt file (History Options>Import/Export), and the search term could be found using the cltl + F/"Find" feature.

All cases where the clinical record suggested a diagnosis of traumatic tail injury were included. If a problem could have been prevented by prior removal of the tail (and not occurred elsewhere on the body), it was included.

Excluded were any cases of adenoma, lipoma, cancers, skin conditions, and self-trauma, as presumably these can and do occur elsewhere on the body, and docking the tail would not prevent them. Although tail amputation might be a treatment option in cancer cases, tail docking is justified by its assumed ability to prevent traumatic injuries to the tail.

For each included case, the dogs' individual identity number (assigned by Vision), the breed, sex, and nature of injury were recorded on an Excel spread sheet. The injuries were then classified according to their cause.

The search was run again with the same keyword, species and date range to show how many dogs in total had come into each clinic over the same period to provide a denominator.

Results

The total number of dogs seen by both vet clinics was 4,316 individual dogs. The first clinic treated a total of 3,106 individual dogs in the study period including 28 with tail injuries (0.9%). The other saw a total of 1,210 individual dogs and 32 tail injuries (2.6%). As a total, 1.39% of dogs observed over the ten year study period in these two clinics suffered tail injuries. These totals assume that no dog visited both clinics. It is interesting to note that both clinics had roughly the same number of tail injuries presented, despite one clinic seeing more than twice as many dogs in the ten year period as the other.

The vast majority (38.3%, n=23) of tail injuries had no specified cause. The most common specified cause of injury was "accident" (22.3%, n=7) and half of these accidents involved the tail being shut in a door. 13.3% (n=8) had knocked or repeatedly knocked their tail against objects, 6.7% (n=4) had been involved in an attack from another animal, and 5% (n=3) had appeared to injure their tails through some form of exercise.

No information was provided regarding whether individuals had docked tails, but 10 individuals (16.4%) belonged to traditionally tail docked breeds. Non-docked breed dogs, suffered the remaining majority of tail injuries. Crossbreeds were presumed to be non-docked for these purposes because they are not traditionally tail docked, so it is unclear how many such docked tails were among the cases.

Crossbreeds (22.95%, n=14) and Labradors (18.3%, n=11) were among the top breeds suffering injury.

Some information overload was experienced as a result of using such a general search term. This included data for any condition that affected the base of the tail, descriptors of behaviour (i.e. “tail wagging”, “tail between legs”), the procedure of “tail jack” and a large number of clinical records which contained the word “detail” but no other mention of the intended search term. These needed to be found and excluded manually. The fact that a second search was necessary to find which of the individual records contained the search term made the process inefficient which could have led to inaccuracies.

Discussion

The possibility that there were overlaps cannot be ruled out; some dogs in the population may have actually been to both clinics over the ten year period, as the clinics were located close to one another.

There was no information gathered on the total number of dogs of each breed seen by the clinics over the study period as the software was no conducive to finding such information. This meant it was not possible to not gather comparative numbers for the numbers of docked/non-docked breeds or a denominator for the number of dogs seen in total to divide by the number of injuries per breed. Both crossbreeds and Labradors are commonly owned breeds and this will go some way to accounting for the high number of tail injuries seen in these breeds.

There was no way to determine from the study whether or not these individuals actually had docked tails unless it was specified in the clinical notes, but it did not appear to be habit of the vets to specify this unless relevant. It is assumed that an obvious trauma such as “shut in door” would be reasonably difficult, though not impossible to do to a docked tail. However the results showed that traditionally tail docked breed dogs can also injure their tails the extent that a vet visit is warranted.

The choice to exclude cases of self-trauma and cancer differs from the methodology of Diesel et al, 2010, where types of self-trauma were included as there was some evidence these could be a manifestation of a prior or on-going injury.

Included were cases of cysts or non-specific lumps where the notes made no mention of symptoms of cancer or other lumps on the body. This was in order to include lumps that may have been the result of trauma. This differs from the final methodology, where it was deemed more correct to exclude a lump that may have been the result of injury rather than assume all lumps of unknown cause are the result of injuries. It is possible that conditions that may have in fact been injuries were excluded, where this wasn't obvious from the clinical notes.

Proponents of tail docking say that the procedure is of particular importance to dogs that are used for hunting or farm work as these activities, or the breeds used for them are at particular risk of tail injury. Both of the clinics used in this pilot study are urban, based in the suburbs of New Zealand's capital city, Wellington, so their databases could be less likely to contain incidents of tail injury resulting from such activities, when compared to the database of rural practices. Many of the injuries seen here are the result of kennelling and confinement or dangers that many indoor or pet dogs are exposed to, such as doors, cars, and interactions with people and other pet animals. This demonstrates that tail injuries can and do result from a variety of different activities – as an example, one dog was seen to suffer an injury after surfing. Possibly, further study which compared rates and causes of tail injury in rural vs. urban environments could produce some useful findings.

Because of the sensitive nature of the search engine used in Vision, any typographical errors where the only incidence of the string 'tail' was disrupted (e.g. "tial") will have been missing from the search.

This pilot study demonstrated that it was possible to use VisonVPM in such research, but that the process was somewhat convoluted and that to conduct the study across a large number of clinics nationwide would be difficult. Researchers contacted developers to see if they could help us conduct the search more efficiently.

Chapter 5: Improved Methodology

SQL script

Following the methods described in the above pilot study would have been labour intensive if working with data from a large number of clinics nationwide, as the manual nature of searching, particularly the secondary search, would take a great deal of time. In addition the researcher would have had to visit the clinics in person, requiring extensive travel, and would require use of a clinic computer for several hours at a time. This would have been inconvenient for both the researcher and the participating clinic, so would have been likely to negatively impact the response rate.

The nature of this research, including initial findings from the pilot study, was discussed with Provet, the developers of VisionVPM. In response to identified difficulties during the pilot study, a specific query SQL script was written to find the data required and present it in a form that could be exported by the staff member to Excel, saved as a spread sheet and emailed directly to the researcher.

Detailed instructions were provided to participants and assistance was available from the VisionVPM help desk.

The SQL script run window was found under Help>Run SQL script. The clinic needed to obtain the password of the day by phoning Provet in order to use this feature. Staff had to then input the SQL script provided by copying and pasting it from text in the email sent to them. The staff also had to input the date range (January 1st, 2004 to January 1st 2012) into Optional Date Fields. The SQL was then run and prompts agreed to.

The script would find all incidents of the word “tail” in the clinical notes of canines visiting the clinic over the study period, and collate the name and ID number of the animal, the date of birth, the date at the time of injury (to calculate the age of the animal at the time of injury), the breed of the dog, and the clinical notes field.

Results then displayed in the lower field of the same window and were exported to Excel by clicking on the button as show in Fig. 4.

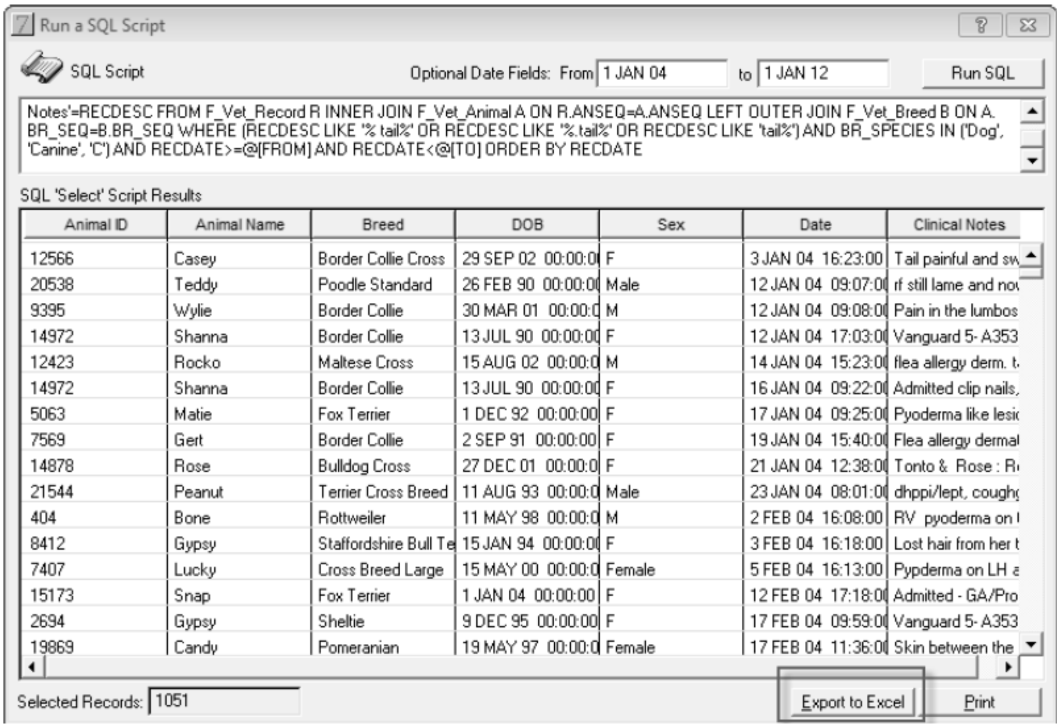

Figure 4: The SQL results window of VisionVPM (example data only) prior to search results data being exported to Excel (screenshot courtesy of V. Lintott, Provet)

Clinic staff could then save this Excel spread sheet under the name of the clinic, and then email this as an attachment to the researcher.

The entire process was then repeated with a slightly different version of the SQL script, which when run would provide the details of the compliment of the original search; i.e. all canine vet visits that did not contain the word tail in their clinical notes.

An additional benefit was that this method protected against privacy issues, as any other commercially sensitive or private information regarding the client, such as address, telephone number or even name, were not included in the spread sheet, and were never visible to researchers. A separate clinical record would be made for each time an individual attended the clinics, so dogs which had attended the clinic several times would have several records. Species (dog/canine) was specified by the SQL script, but the clinics had to manually specify the date range.

The new script helped alleviate information overload somewhat by only retrieving incidents of the word “tail” when a space was on either side of the word, so no false “detail” or “retail” cases would come up.

The SQL script only returned the first thousand characters in a clinical notes field. This meant that occasionally, a clinical notes cell in Excel would not actually contain the word tail. It is reasonable to assume that if the word tail does not appear in the first 1000 characters of a clinical notes field, it is unlikely that the dog is visiting the clinic because of a tail injury.

Recruitment

Because the study was retrospective, ideally clinics that had been using Vision VPM long term needed to be recruited. A number of clinics began using the service in 2003, so an 8 year retrospective allowed 108 clinics to be invited to participate. These clinics were contacted first by post and subsequently by email and fax to ask if they would participate in this study. Additionally a small announcement was also sent to the members of the NZVA Companion Animal Society executive committee’s mailing list.

A permission slip was issued to clinics containing the name of the clinic, the version of the software they were currently running and whether or not the clinic was in a position to upgrade their software to allow the SQL script to be used. These slips were then signed and dated. Clinics could also give their consent via email.

To run the SQL script, use of VPM build 344.12 was required. Clinics still using older versions were required to upgrade. Updates such as these occur periodically so it was hoped that clinics would be able to do this with ease. Detailed instructions on how to run the SQL script and keyword search were provided to clinic staff. The resulting Excel spread sheets were returned by email.

To recruit controls, the same clinics underwent a similar process but with an SQL script which recalled the complement of the initial search; that is, all canine cases where the word tail was NOT included in the clinical notes. The same information regarding the dog and date of injury was recorded. Controls did not have to be manually checked, so the clinical notes field was not included making the spread sheets a more manageable file size. From these, corresponding controls were randomly selected for each tail injury case.

Manual filtering

To make finding the word "tail" within the clinical notes easier, the Find and Replace feature of Excel was used to replace all incidents of the word "tail" with the string "***tail***". The clinical notes were read to determine whether the record contained a tail injury and to categorise them by cause and find the ultimate treatment used. Records were scanned to find how many cases required revisits.

Case definition

The justification for tail docking is to prevent traumatic injury to the tail, in particular hunting or working farm dogs. Many other problems can be treated by amputation of the tail such as cancer, self-trauma and on-going allergies, but these were not included because prevention of such problems is not the usual justification for tail docking. In addition, many of these problems can and do occur elsewhere on the body.

Therefore case definition was any dog that came into the clinic for the express purpose of having a traumatic tail injury observed or treated by a vet. Injury needed to be specified by either the owner or the vet's diagnosis. This differed from the case definition of Diesel et al. (2010), which included cases of self-mutilation because this can sometimes be the result of a prior injury. This was considered erroneous as it assumes that all self-mutilations are the result of past traumatic injury when they can also be caused by allergies and neurotic disorders. For the purposes of this study, cases of self-injury were not included.

Tail lesions that were not specified as being caused by injury were not included. Because these can have other non-injurious causes, we considered it would be incorrect to include all of them as cases, and more accurate to rule them out instead. This differed from the pilot study; initially all tail lesions were included so that no injuries would be mistakenly excluded.

Cases of puppies visiting the clinic for the procedure of tail docking were not included in the analysis but if injury or infection resulted shortly afterward, the dog would have a new visit which created a separate record and this would then be included as an injury case.

Because of the nature of the keyword search, all other records that mentioned the word tail in their clinical notes but were not in fact a tail injury case had to be manually removed. These included, in no particular order:

- Skin conditions, including pruritus of the tail, flea allergy dermatitis and self-trauma resulting from these conditions.
- Any and all neoplasias or lesions of an unknown cause presenting on the tail.
- All instances of tail docking
- Prior to the use of the SQL script, notes that included some words that contained tail, but no other mention of the word, including “details” “retail” “tailor”
- Dogs that had injured themselves in the “tail gate” of a utility vehicle, or were bitten by a “white tail” spider
- Descriptions of sperm samples with broken or coiled tails
- Descriptions of the dog’s behaviour that referred to the tail “i.e. much brighter, tail wagging today” or “not happy in himself, tail down between legs”

As the literature recommends, the researcher manually inspected the records resulting from the search to categorise them and exclude those that were not tail injuries. Where such non-cases were excluded, they were placed back into the control group.

Categorisation of causes

Manual inspection of the case records revealed a range of specific causes of injury. These were grouped into a number of categories, as shown in the table below.

Unknown	No cause specified in the clinical notes
Attack	Fight or attack with another dog, or other animal
Exercise	Injury sustained after prolonged or vigorous playing, swimming or other activity
Docking	Injury resulting from docking of the tail as a puppy.
Knocking	Repeated knocking of tail on objects to the point where it becomes difficult to heal
Door	Tail shut in the door of a car or house, does not include gates
Vehicle	Hit by car or other vehicle; also includes falling/jumping off of the back of a utility vehicle or out of moving cars. Does not include injury by farm vehicles (see below) or tail being shut in car door (above)
Farm work	Kicked or trodden on by cattle, sheep etc. Injuries due to gates and fencing (including electric fencing). Injured by farm vehicle.
Hunting	Injured during hunting.

Table 1: Categorisation of Tail Injury Causes In Dogs Visiting 16 New Zealand Veterinary Clinics Between 2004 And 2011

Severity

Revisits

In order to draw conclusions regarding the severity of tail injuries, the number of revisits necessary to “resolve” (meaning revisits ceased) each injury was recorded. A revisit had to be the same dog for the same complaint within the same year.

Ultimate treatment

Because many dogs had several treatments, the final or most severe intervention necessary to resolve the tail injury and associated issues was recorded. Interventions were listed in order of severity in Table 2.

Ranking	Treatment/intervention
1	Euthanasia
2	Tail amputation or partial amputation
3	Other surgery/sutures
4	Bandage
5	Oral or injectable drugs
6	Topical treatments only
7	No treatment

Table 2: Ultimate/Final Treatments of Canine Tail Injury Cases from 16 New Zealand Vet Clinics 2004-2011, Ranked According To Their Assumed Severity

For example if a dog was initially treated with minor surgery, but complications arose leading to the need to have the tail amputated, then amputation would be the ultimate treatment. Should the dog come in subsequently to have a bandage changed or receive antibiotics, amputation would remain the most severe intervention and therefore be the treatment category for that injury.

Because amputation is thought to be a relatively severe intervention, and presumably the outcome that docking is supposed to prevent, we investigated this particular treatment category as to its cause.

Dogs in both case and control groups were classified as traditionally tail docked according to a list of traditionally docked breeds as compiled by the Council of Docked Breeds (UK). Any dog belonging to a breed not on this list (including crossbred dogs) was considered not traditionally tail docked.

To observe breed as a risk of injury, the twenty most common breeds in this study were listed. Their relative risk was calculated based on the number of tail injury cases relative to the number of total individuals of that breed seen by the clinic for any reason.

Statistical Methods

Most of the statistics in this study are descriptive in nature, but a case control study was also conducted to investigate risk factors for injury. A case control study is commonly used in epidemiological studies and compares the rates of disease in exposed and unexposed individuals. In this study the “disease” was tail injury. The possession of a tail (i.e. belonging to a non-docked breed) was considered "exposure" to the disease, because the possession of a tail would be expected to predispose an animal to injuring that tail, when compared with individuals that have no tail. This was based on breed only as we had no information about the actual tail docking status of individuals.

Rural dogs would presumably be more likely to be involved in hunting or farming activity and the risk of tail injury is thought to be high from such activities. An additional level of exposure was investigated based of whether a dog was from a rural or urban area, determined by clinic location. If a clinic was located in a one of New Zealand's top ten most populated urban areas (as defined by Anon/Statistics New Zealand 2012) it was considered an urban clinic. If the clinic was found in a smaller centre, it was thought to primarily serve surrounding rural areas and was classed as a rural clinic.

A Mantel-Haenzsel odds ratio was calculated using R v2.15.2 for Windows,(The R Foundation for Statistical Computing, Vienna, Austria), stratifying by the location of the clinic (urban vs. rural). Exposure was considered the presumed presence of a tail in dogs belonging to undocked breeds.

Chapter 6: Results

Response rate

Sixteen clinics participated in this research. Other clinics that responded to the request were either not using VisionVPM or were not able to upgrade to the latest platform.

The participating clinics were not randomly enrolled, however were geographically spread throughout the regions of New Zealand, with five clinics in Auckland participating. Both rural and urban clinics appear well represented. Almost 1/3 of responding clinics were from Auckland, mirroring human population distribution in New Zealand.

Figure 5: A map of the geographical spread of 16 participating vet clinics in a study of canine tail injuries in New Zealand 2004-2011(image courtesy of Google Maps)

Data mining

As expected, the rather simple keyword search methodology did result in a degree of information overload.

Out of the 7,386 records that returned with the search term "tail" only 623 (8.4%) actually referred to individual tail injuries.

Data analysis

From the 16 clinics, data on 623 tail injuries from 619 individual dogs (3 individuals suffered two separate, unrelated tail injuries each) was collected over a retrospective eight year period, as well as control data from a further 68,653 individual dogs over the same period. This demonstrates that tail injury is relatively rare, with 0.9% (n=619) of individual dogs visiting vet clinics due to a tail injury. 96 out of 619 (15.51%) were tail injuries in traditionally tail docked breeds.

Sex ratio for injuries was roughly 1:1 (49.76% males). 15 dogs (2.4%) had no sex specified on their clinical records.

Age

Dogs most commonly suffered tail injuries around the age of two (see Fig. 10) and the risk consistently dropped as they aged.

Seasonal Trends

Tail injuries were seen at reasonably even rates across the eight year study period (Fig. 7). Seasonally there was no discernible trend (Fig. 8). A dog was approximately as likely to injure the tail in summer as in winter. Autumn was the least likely time for a dog to injure the tail, and it was most common (though not substantially more so) for dogs to injure their tails in the spring.

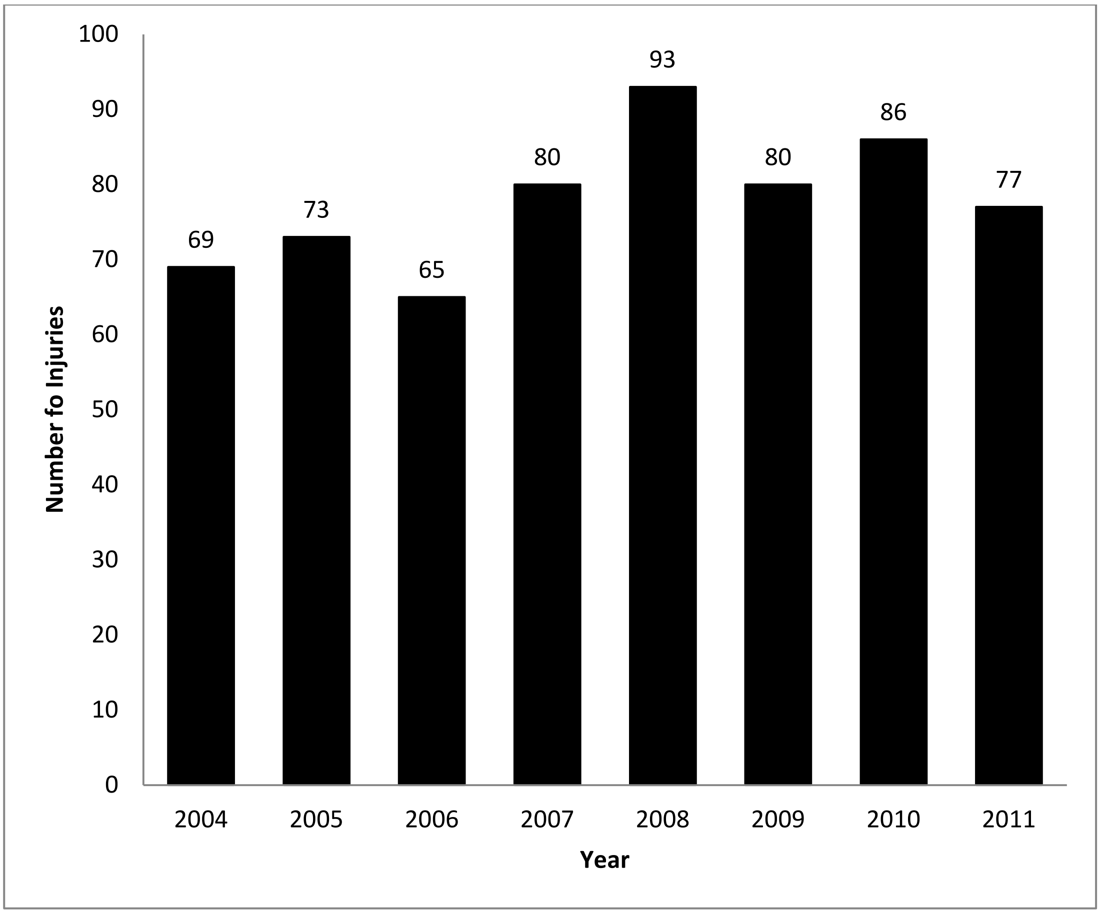

Figure 6: Canine tail injuries by year (n=623) dogs presented to 16 vet clinics in New Zealand between 2004 and 2012.

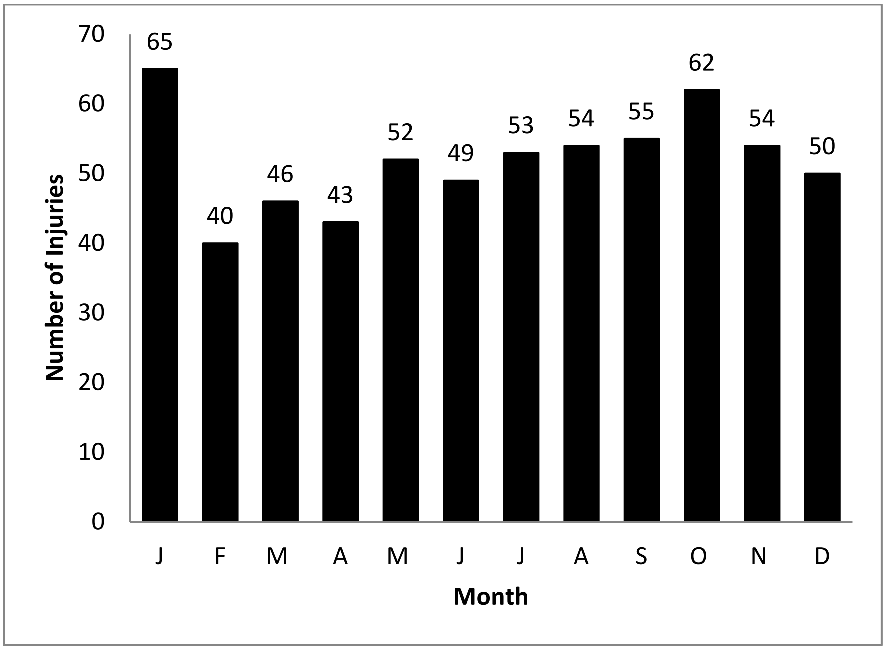

Figure 7: Graph for canine tail injuries by month (n=623) presented to 16 New Zealand vet clinics 2004-2012.

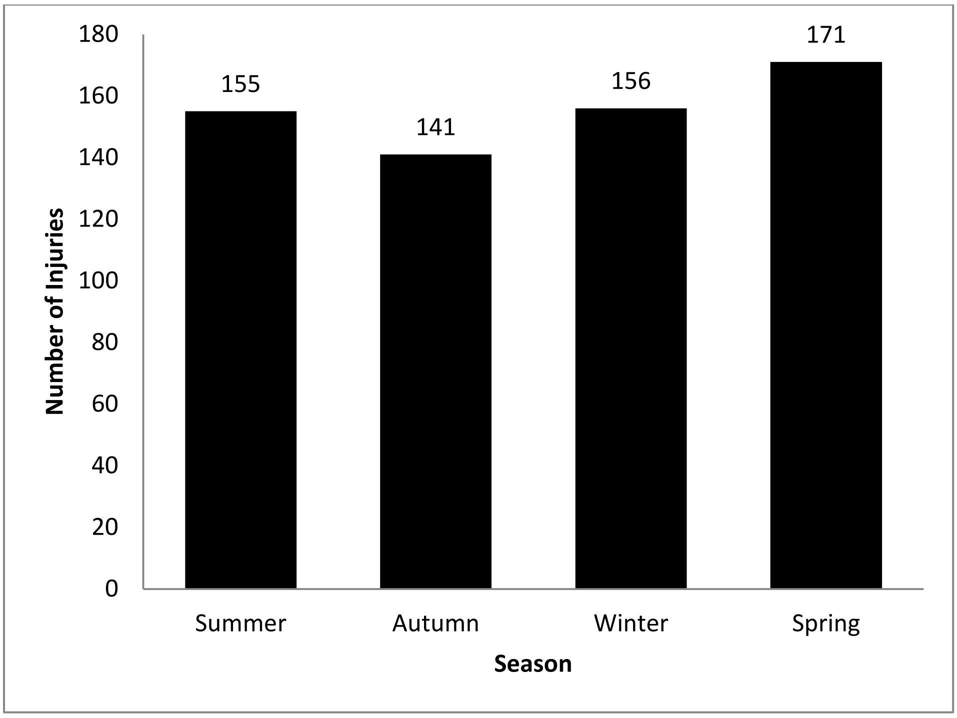

Figure 8: Seasonal spread of 623 canine tail injuries seen by 16 vet clinics in New Zealand 2004-2011.

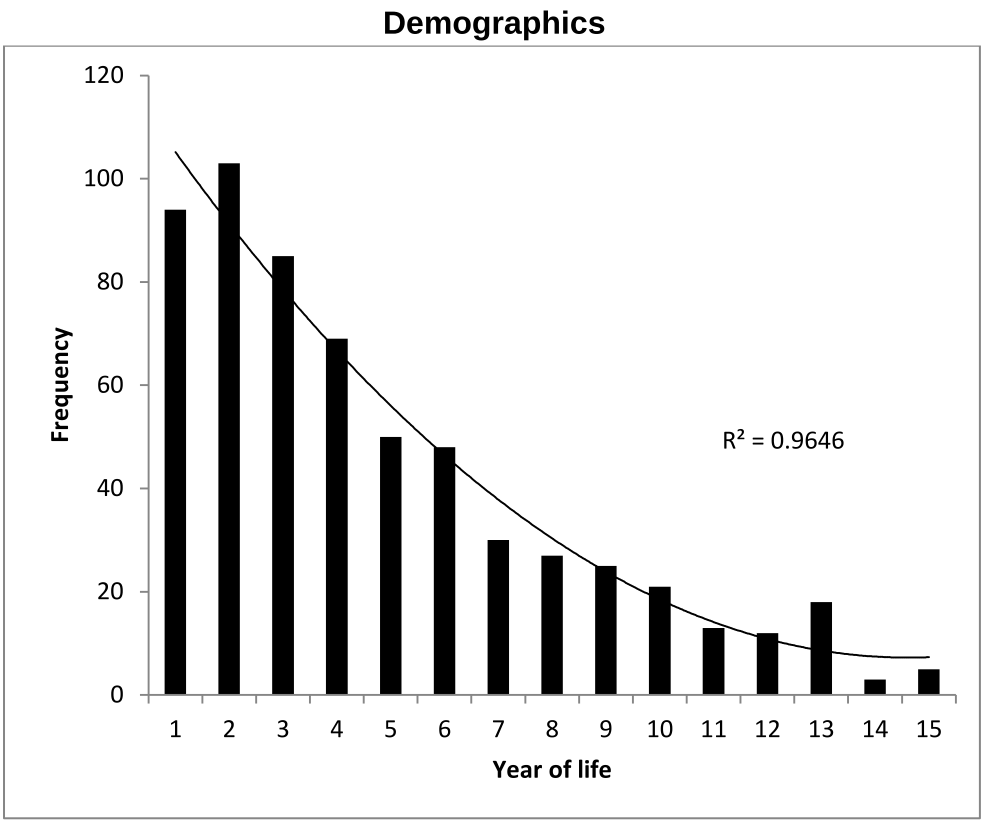

Figure 9: Histogram showing age distribution of 608 tail injuries seen in dogs by 16 vet clinics in New Zealand between 2004 and 2011 (15 dogs had no age specified).R^2 = 0.965, suggesting that the trend line is a close approximation of actual values.

The histogram for age (Fig. 6) suggests that dogs tend to injure their tails early in life, particularly in their second year. The correlation coefficient (Pearson's r) for the relationship between age and tail injury was -.94, indicating a strong negative relationship; tail injuries became less frequent with age.

Breed as risk of injury

Out of the twenty most popular breeds, dogs identified as Labrador retrievers or Labrador crosses were the most likely to injure their tails, with 100 cases of tail injury out of a total 7189 cases (1.4%).

Breed	Total no. individuals admitted 2004-2011	Breed popularity ranking	Cases	Percentage of individuals suffering tail injury
Labrador Retriever/X	7189	2	100	1.39
Pig Dog	1747	9	23	1.32
Pit Bull Terrier Cross	642	17	8	1.25
Crossbreed	7809	1	91	1.17
Golden Retriever	1365	11	14	1.03
Huntaway/X	5864	3	60	1.02
Boxer	**972**	**13**	**9**	**0.93**
Springer Spaniel	**489**	**20**	**4**	**0.82**
Rottweiler	**856**	**15**	**7**	**0.82**
Heading Dog/Collie	3507	7	27	0.77
Staffordshire Bull Terrier/X	2421	6	18	0.74
German Shepherd	1694	10	10	0.60
Australian Cattle Dog	529	18	3	0.57
Chihuahua	884	14	5	0.57
Jack Russell Terrier	2652	5	14	0.53
Cocker Spaniel	**768**	**16**	**4**	**0.52**
Fox Terrier/X	**3331**	**4**	**16**	**0.48**
Bichon Frise	1128	12	5	0.44
Schnauzer, Miniature	**499**	**19**	**2**	**0.40**
Border Collie	2027	8	7	0.35

Table 3: Ranking of proportion of tail injuries in the 20 most popular breeds seen by 16 New Zealand veterinary clinics from 2004-2011. Breeds in bold are traditionally tail docked. Breeds are ranked for their popularity according to the total number of individuals of that breed seen by a vet for any reason

Tail-docking status as risk of injury

No information was provided regarding whether or not individual dogs in this study were actually tail docked, because this was not routinely recorded by vets. However it is known that only 15.4% (n=96) of the injuries were suffered by dogs belonging to breeds that are traditionally docked. The assumption is that the majority of these individuals will actually be docked because undocked examples of traditionally docked dogs are rare (Leaver and Reimchen 2008).

Causes of injury

The cause of tail injury was known in 289 (46.4%) of injuries. The cause was not stated in the clinical notes of the remaining 334 cases (53.6%). Table 4 shows the known causes of tail injuries in dogs in the study.

Causes of injury	n	% of injuries of known cause (n=289)	% of total injuries (n=623)
Accident	83	28.7	13.3
(non-door)	42	14.5	6.7
(door)	41	14.2	6.6
Vehicle	62	21.5	10.0
Exercise	33	11.4	5.3
Attack	31	10.7	5.0
Hunting	27	9.3	4.3
Docking	24	8.0	4.0
Knocking	16	5.5	2.6
Farm work	13	4.5	2.1
TOTAL	289	100	46.4%

Table 4: Known causes of 289 canine tail injuries seen by 16 New Zealand vet clinics from 2004 to 2011. An additional 334 injuries (53.6% of total) were of an unknown cause.

The most common were “accidents” (28.7%. n=83) almost half of which resulted from the tail being shut in a door (6.56%, n= 41). The other 42 (14.5%) were made up of all manner of other freak accidents that were not the result of doors, hunting or working. The second most common causes of injury were vehicle related (n=62, 21.5% of known causes); that is, being hit by a car (or any other non-farming vehicle) or from falling out of a car window or off the back of a utility vehicle. Farm-specific injuries only accounted for 2.1% (n=13) of injuries and hunting accidents only 4.3% (n=27). 4.0% (n=24) were actually caused by tail docking that resulted in infection or other problems.

Causes of injury in traditionally docked breeds

Cause	n	% of injuries of known cause in traditionally docked breeds (n=50)	% of total injuries in traditionally docked breeds (n=96)
Docking	21	42	21.9
Attack	10	20	10.4
Accident	13	26	13.5
(door)	8	16	8.3
(non-door)	5	10	5.2
Vehicle	3	6	3.1
Exercise	2	4	2.1
Knocking	1	2	1.0
Total	50	100	52.1

Table 5: Known causes of tail injuries in 50 dogs belonging to traditionally tail docked breeds, as seen by 16 New Zealand vet clinics 2004-2011. 46 injuries (47.9% of total) were of an unknown cause.

Causes of injury were known in 50 (52.1%) traditionally tail docked dogs. These causes are listed in Table 5.The most common known cause of injury in traditionally tail docked dogs was docking itself (42% of known causes, n=21). Second most common was by the dog injuring their tail in an attack (20%, n=10).

Farm work injuries by breed

Breed	n	% of farm injuries (n=13)	% of total injuries (n=623)
Huntaway	4	30.8	0.6
Heading Dog/Collie	3	23.1	0.5
Crossbreed	2	15.4	0.3
Bearded Collie Cross	1	7.7	0.2
Dachshund (standard)	1	7.7	0.2
Maltese Terrier Cross	1	7.7	0.2
Staffordshire Bull Terrier	1	7.7	0.2
TOTAL	13	100	2.1%

Table 6: 13 farm work-related canine tail injuries as seen by 16 New Zealand vet clinics (2004-2011), categorised by breed. None of the above breeds are traditionally tail docked.

All injuries occurring as a result of farm work were broken down by breed (Table 9). The most common breed to injure the tail on the farm were Huntaways (30.8%, n=4). Heading dogs or collies (23.08%, n=3) were the second most common breed to have their tail injured on the farm, followed by crossbred dogs (15.39%, n=2). Four other breeds suffered a single injury farm-related each.

Hunting injuries by breed

Breed	N	% hunting injuries (n=27)	% total injuries (n=623)
Pig Dog	14	53.9	2.3
Crossbreed	6	23.1	1.0
Huntaway Cross	2	7.7	0.3
Australian Cattle	1	3.9	0.2
Bull Terrier	1	3.9	0.2
English Pointer	1	3.9	0.2
Heading Dog	1	3.9	0.2
Whippet	1	3.9	0.2
TOTAL	26	100	4.3

Table 7: 26 hunting-related canine tail injuries as seen by 16 New Zealand veterinary clinics (2004-2001) categorised by breed.

Hunting injuries were categorised by breed (Table 9). Dogs identified as pig dogs most commonly injured their tails while hunting (53.85%, n=14), followed by crossbred dogs (23.07%, n=6), and then Huntaways (7.69%, n=2). The other breeds listed (Australian Cattle dogs, Heading Dogs, whippets, bull terriers, and English pointers) had a single representative with a hunting injury.

Labradors were the most popular breed in this study, outnumbered only by the various cross breeds. Huntaways were the breed most often injured on the farm. Over half of the dogs that injured themselves hunting were identified as Pig Dogs (51.9%, n=14). We used these popular breeds to make assessments about the risk to certain types of injury based on presumed use.

Injuries by presumed use						
	Labradors		Huntaways		Pig Dogs	
	%	n	%	n	%	n
Unknown	60.19	62	62.30	38	34.78	8
Vehicle	8.74	9	3.28	9	0	0
Accident	6.80	7	6.56	4	0	0
Door	7.77	8	3.28	3	4.35	1
Hunting	0	0	3.28	2	**60.87**	**14**
Farm work	0	0	**1.64**	**4**	0	0
Exercise	**14.56**	**15**	0	0	0	0
Knocking	0.97	1	1.64	1	0	0
Attack	0.97	1	0	0	0	0
TOTAL	100	103	100	61	100	23

Table 8: Causes of canine tail injuries in pet (labradors), hunting (pig dogs) and farm (huntaways) dogs as seen by 16 New Zealand vet clinics.

Severity

Revisits

77.4% (n=482) of tail injuries were resolved in a single vet visit with no revisits (Figure 7). A further 12.7% (n=79) had a single revisit, and an additional 6% (n=37) had two revisits. The remaining 4% (n=25) required further treatment, with the maximum number of times a dog returned to the clinic for a single tail injury being 11 times.

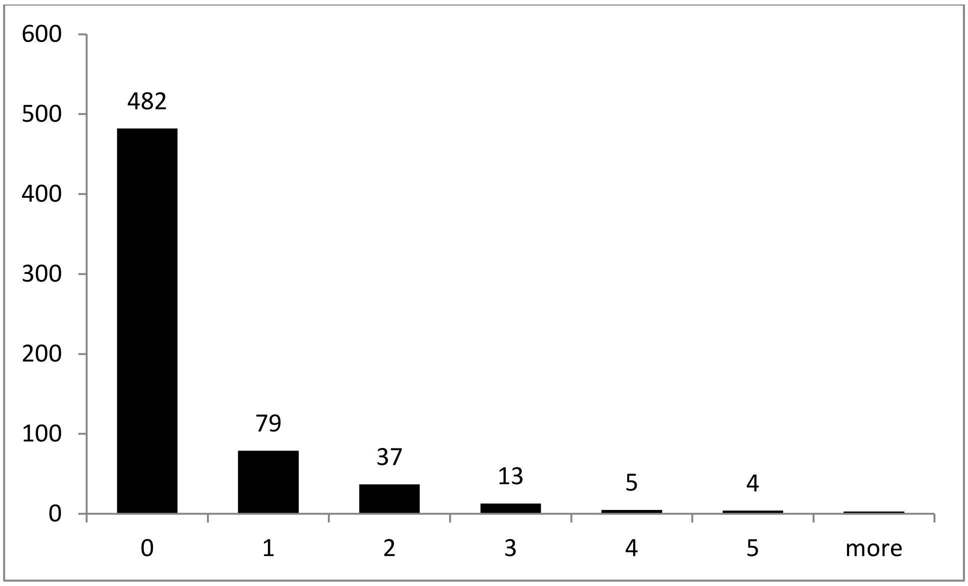

Figure 7: Number of clinic revisits required to resolve tail injury in 623 dogs seen by 16 New Zealand vet clinics from 2004 to 2011. The vast majority were resolved with a single visit to the vet.

The cause of tail injury was unknown in 67 of 141 (48%) of dogs which required revisits. The major causes of injury in cases which required revisits were much the same as the causes of injury in all cases, though vehicle injuries were the third most common cause in this group and the first in total injuries. Dogs that injured their tails through exercise never required revisits.

Cause of injury in dogs requiring revisits.		n	% of revisit cases with known cause	% of total cases
Accident		28	38.9	5.0
	non-door	14	19.4	2.3
	door	14	19.4	2.3
vehicle		12	16.7	1.9
knocking		8	11.1	1.3
hunting		7	9.7	1.1
attack		6	8.3	1.0
docking		6	8.3	1.0
Farm work		5	6.9	0.8
TOTAL		72	100	623

Table 9: Cause of tail injury in 72 dogs requiring revisits as seen by 16 New Zealand vet clinics 2004-2011. Cause of injury was unknown for an additional 67(48%) injuries which required revisits.

Ultimate intervention required

Treatment	n	% of cases
Drugs (analgesics, anti-inflammatories etc.)	318	51.0
Amputate (total or partial)	86	13.8
No treatment	63	10.1
Not specified in clinical notes	63	10.1
Minor Surgery or sutures	45	7.2
Bandage	26	4.2
Topical	12	1.9
Euthanasia	10	1.6
TOTAL	623	100

Table 10: Final/most severe interventions used to resolve 623 canine tail injuries seen by 16 New Zealand vet clinics from 2004 to 2011. Cases were considered resolved when revisits to the study clinic ceased.

More than half (51.0%, n=318) of the injuries presented to clinics over this period were treated and presumably resolved (as no subsequent revisits) by oral or injectable medications such anti-inflammatories, analgesics and antibiotics. Partial and total amputations were the second most common outcome, but this occurred in only 13.8% (n=86) of tail injury cases.

Minor surgeries (7.2%, n=45) included procedures besides amputation performed under general anaesthetic, such as the removal of a foreign body, sutures and debriding of dead tissue.

However, another fairly common (10.1%, n=63) outcome of a vet visits was no treatment at all, where clients were told simply to monitor the dog's condition and did not return to the vet within the study period. An equal number of times no information regarding treatment was specified in the clinical notes.

The very small number (1.6%, n=10) of euthanized animals usually suffered tail injuries after vehicular accidents and were euthanized as a result of other injuries or complications. One exception to this was the case of one dog with tail injuries so severe it had to be euthanized for welfare reasons when owners could not be contacted regarding treatment.

Eighty-six tail injuries (13.8% of total) resulted in partial or total amputation of the tail. The causes of these injuries are outlined in Table 8.

Dogs were twice as likely to require amputation as the result of an accidental, door or vehicle related injury than they were for a farm related one. Chronic issues related to repeatedly knocking the tail were more likely to result in amputation than were injuries resulting from hunting activity.

Cause of injury when treated with amputation

Cause	n	% of amputation cases (n=86)	% of total tail injury cases (n=623)
Unknown	44	51.16	7.1
Accident	8	9.30	1.3
Door	8	9.30	1.3
Vehicle	8	9.30	1.3
Knocking	6	6.98	1.0
Hunting	5	5.81	0.8
Farm work	4	4.65	0.6
Docking	2	2.32	0.3
Attack	1	1.16	0.2
TOTAL	86	100	13.8%

Table 11: Causes of 86 cases of canine tail injury which resulted in partial or total amputation of the tail, as seen by 16 vet clinics in New Zealand from 2004 to 2011.

Case control study

	Dogs presented urban centre clinics	
	Case	Control
Not tail docked	199	207
Tail docked	34	63

Table 12: Tail injury cases and controls presented to eight urban clinics in New Zealand between 2004 and 2011.

	Dogs presented to rural centre clinics	
	Case	Control
Not tail docked	321	272
Tail docked	62	74

Table 13: Tail injury cases and controls presented to eight rural clinics in New Zealand between 2004 and 2011

The odds ratio for the first stratum (urban dogs) was 1.4, the odds ratio for the second stratum (rural dogs) was 1.7, and the cumulative odds ratio if the data were pooled is 1.55. The Mantel-Haenszel odds ratio is estimated to be 1.55.

The Cochran-Mantel-Haenszel Chi-squared test quantifies the association between disease and exposure. Here a significant association (P=0.003) is shown between the disease (tail injury) and exposure (not belonging to a docked breed, and therefore presumably possessing a tail).

The odds ratio for this risk of exposure was 6.15 (95%CI 5.83, 6.50) meaning a dog with an intact tail was about six times as likely to injure their tail as a docked dog.

Urban versus Rural clinics

A vet clinic was considered "urban" if it was included on the list of New Zealand's fifteen most populous urban areas based on June 2012 estimates (Anon/Statistics NZ, 2012). It is assumed that a clinic that did not belong on this list would be servicing a small town and surrounding rural areas. Of the sixteen clinics surveyed, eight were considered urban and eight considered rural clinics.

		Rural	**Urban**
All dogs		**39536**	**29542**
	Tail docked breeds	1140 (2.9%)	3328 (11.3%)
Injured dogs (%)		**386 (**.98%)	**233 (**0.79%)
	Tail docked breeds	62 (16.1%)	34 (14.6%)
Cause	Hunting	13 (3.4%)	14(6.0%)
	Farm Work	14(3.6%)	2(0.9%)
	Door	21(5.4%)	19(8.2%)
	Vehicle	39(10.1%)	20(8.6%)
	Docking	10(2.6%)	11(4.7%)
Treatment	Amputation	66(17.1%)	19(8.2%)
	No treatment	32(8.3%)	20(8.6%)

Table 14: Causes, treatments and rates of tail injury compared between eight rural and eight urban clinics in New Zealand between 2004 and 2011

A higher total number of dogs were seen at clinics we identified to be "rural". Traditionally tail docked breeds were remarkably more common in urban clinics (11.3% of all dogs seen at all urban clinics, versus 2.9% of all dogs seen by rural clinics). Within the injured population, tail docked breeds were slightly more common in rural practise (16.1%, n=62 compared with 14.6%, n=34).

The rate of injury appeared slightly higher in rural clinics (0.98%) than urban clinics (0.79%). Urban clinics saw a higher incidence of hunting injuries (6%, n=14; rural 3.4%, n=14). Farm work injuries were more common in rural clinics (3.6%, n=14) but still reasonably rare. Such injuries were very rare in urban clinics (0.9%, n=2). Urban clinics were more likely to see injuries that were the result of docking (4.7%, n=11; rural 2.6%, n=10). Door injuries were more common in urban clinics (8.2%, n=19;

rural 5.4%, n=21), but vehicle injuries were more common in rural clinics (10.1%, n=39; urban 8.6%, n=20).

Treatment by amputation appeared to be more than twice as common in rural clinics (17.1%, n=66; urban 8.15%, n=19). Both types of clinics appeared equally likely to recommend no treatment, with rural clinics doing so 8.3% (n=32) of the time and urban clinics 8.6% (n=20) of the time.

Chapter 7: Discussion

Findings

Firstly, these findings demonstrate that the incidence of tail injury in this population is reasonably rare, with less than 1% of individuals surveyed suffering a tail injury over the eight year study period. As expected, that possession of a tail (belonging to a non-docked breed) was found to be a significant risk factor for tail injury.

Causes of injury in traditionally docked dogs

The most common known cause of tail injury in traditionally docked dogs was docking itself (21.9%, n=96).

In comparison, only 14.7% of traditionally undocked dogs (n=77) required amputation to treat their tail injuries. It appears that tail docking is more risky with respect to the likelihood that it would cause injury, than an undocked tail is at risk of requiring amputation. 9.4% (n=96) of traditionally docked dogs required amputation as a result of their injuries, so an injury requiring amputation is still possible even with a docked tail.

The rate at which docked dogs might injure themselves if they were undocked is unknown, but to apply the average rate of injury (0.9%) to the calculations discussed in the first review chapter; the docking of 4000 puppies each year in New Zealand prevents 36 injuries through the lifetime of those dogs. This is 4.5 for every 500 puppies docked. While this is higher than the 1 in 500 figure produced by Diesel et al. (2010) it is still reasonably low. Tail docking as it currently stands only prevents injury in tail docked breeds. As 42% of tail injuries in this group are the result of docking, on average, 15 injuries would be caused by docking while 36 are prevented. The result is a net prevention of only 21 tail injuries, or 2.63 for every 500 puppies docked, which is still higher than, but is much closer to the figure produced by Diesel et al. (2010).

Estimated number of puppies docked per year	4000	500
Rate of injury in general population (0.9%)	15	1.88
Rate of injury caused by docking (42%)	36	4.5
Total net prevention of tail injury	**21**	**2.63**

It is apparent that tail docking as a means of preventing tail injury in dogs is not justified as the number of amputations it would prevent is negated by the rate of injury caused by the act of docking itself. The welfare impact of other injuries which do not result in amputation must also be considered, but the significance of tail docking as a cause of injury must not be underestimated.

The second most common cause of tail injury in traditionally tail docked dogs was "attack", (10.4% n=10) compared with only 3.8% (n=21) in non-docked breed dogs. Tails in dogs play a vital function in intraspecies communication (Fox, and Behoff 1975). It is possible that this high number of attacks is a reflection of increased aggression resulting from impaired communication between dogs. This would be consistent with the findings of Leaver and Reimchen (2008), who demonstrated that it was easier for dogs to read cues from a longer tail than a short one. The attack category also included injuries from cats and in one case a rat, but is worth noting because the discrepancy is large between the two groups.

Interestingly no traditionally docked dogs suffered injuries as a result of farming or hunting. This could be because all or most of the traditionally docked farm dogs are docked and therefore do not or cannot injure their tails.

Severity

Most of the tail injuries seen in this study appeared to have been resolved in a single visit (zero revisits), and the vast majority were treated with drugs only. The tail injury prevention argument assumes that tail docking is less painful or traumatic as a semi-conscious puppy than amputation as a full grown adult. Amputation is a potential outcome for tail injuries, but only 13.8% of injuries in this study resulted in tail amputation. Despite this low number, in an additional 45 injuries (7.2%) where it was not the final intervention, amputation was mentioned in the clinical notes as “recommended”, “likely necessary” a “worst case scenario” or “an option” if problems continued. This was in addition to any on-going behavioural, neurotic or skin conditions outside the scope of this study that would have also been accompanied by a recommendation of amputation. Vets may merely want to warn owners early that tail amputation is a possible consequence of tail injury, but this may not be necessary given the relatively small number of tail injuries that actually result in amputation. Because tail injuries are actually quite rare, an individual vet presumably only sees a handful of tail injuries in his or her career, which may happen to result in amputation. This rarity may create a perception based on anecdotal evidence that tail injury “often” results in tail amputation.

It is assumed that the number of revisits is a good estimate of the severity of the injury, in terms of cost, veterinary professional time used, and stress or pain imposed on the dog. It is easy to see how it might take several visits of on-going problems before, for example, amputation is suggested, and then subsequent visits prove necessary for the removal of stitches or to re-bandage the wound. Not all such visits would represent a cost to the owner, but they could be a stressful and/or painful experience for the dog.

A case was assumed “resolved” when revisits ceased. There are a number of issues with this; for one, the study period was limited and further revisits could have occurred after this period. Similarly, visits at the beginning of the study may have in fact been revisits where the original visit was not captured. It is also possible that clients moved or changed vets during the study period so it was not possible to see the consequences of therapeutic interventions, nor accurately record the number of times a dog saw any vet for a tail-related issue.

Cases were considered “resolved” by amputation as there is no further intervention a vet can take and revisits ceased within the study period. Further visits in the future may have revealed consequences of tail amputation, such a behavioural issues, amputation adenomas or infections. It would be interesting to investigate the success of amputation long term – a number of tail injuries in this study were the result of bad docking or complications arising at a prior amputation site.

Tail docking Status

Out of the 69,273 dogs seen by the vet clinics over the ten year study period, 12,989 belonged to tail docked breeds. Traditionally docked dogs accounted for 96 of the 619 dogs which suffered tail injuries. This means that traditionally docked dogs suffered tail injuries at a rate of .74% and traditionally undocked dogs at a rate of .93%. This shows that traditionally undocked dogs have a slightly higher risk of tail injury, but the risk is still very low in both groups.

The vast majority of injuries happened to dogs that are traditionally left intact, or crosses, which do not have to adhere to a specific breed standard and presumably are not docked. A tail that occupies more physical space is likely more susceptible to injury (e.g. easier to catch in a door). It is impossible to know for certain whether this lower number was because these dogs' tails were docked and therefore less likely to be injured, or whether individuals of traditionally docked breeds that did suffer tail injuries did so because their particular intact tail put them at risk.

These findings are based on the assumption that individuals belonging to traditionally docked breeds are in fact docked. This is thought to be a reasonable assumption, because where docking is permitted, full-tailed representatives of these breeds are uncommon (Leaver and Reimchen 2008). Tail docking has become a relevant issue in the past several years, which may have seen a demand for full-length tailed dogs increase; however it is not erroneous to assume for the purposes of this study that the vast majority of traditionally docked breed dogs are in fact docked.

Hunting and farming as causes of injury

Although hunting and farming are recognized by as being particularly problematic in terms of tail injury (Warman, 2004 and Dyer, 2004), only 4.3% (n=27) and 2.1% (n=13) of injuries were identified as being the result of each cause respectively. Hunting injuries were comparable with the number of injuries caused by docking (3.85%, n=24). Far more common were injuries which resulted from accidents, particularly door or vehicle related. These types of injuries can and do occur in a variety of breeds, pets and working dogs alike. If it were justifiable to dock the tails of working dogs because of risk of injury, then it would presumably be justifiable to dock tails of all different breeds, regardless of their use. It appears that this would prevent far more injuries, as injuries resulting from accidents that are not farming or hunting related are far more numerous.

Farm work

Huntaways were the breed most commonly injuring themselves in farm situations (30.8%), followed by Heading dogs/collies and crossbreeds. Huntaways are a very popular breed in New Zealand, and followed by crossbreeds and Labradors, were the third most popular breed seen by vet clinics in this study. The remaining four breeds that had injuries each had a single representative only. It is clear from these results that not only traditional working breeds appear to injure themselves in a farm setting. It must be noted that the number of farm-related injuries was actually very low - only 13 injuries out of the 623 observed – so it is questionable whether any meaningful information can be garnered regarding their nature. However it does demonstrate that if tail injuries themselves are rare, then tail injuries resulting from farm work are even rarer. It is possible that farm dogs would be less likely to see a vet than an urban pet, but if they do not warrant veterinary attention, it is assumed that the tail injuries such dogs suffered were reasonably minor.

Hunting

Though not technically a breed, over half of the dogs that injured their tails while hunting were identified as “pig dogs”. Crossbreeds were the next best represented and then Huntaways. This was consistent with the assertion of Dyer (2005); none of these three are NZKC registered breeds. Any remaining injuries were single representatives of a given breed. Again, with only 27 injuries found to be the result of hunting activity, is probably reasonable to assume that they are very rare but is difficult to draw any strong conclusions regarding the nature of hunting injuries. In addition there may well have been hunting injuries for which veterinary attention was no sought. This could either be because the injuries were not severe, or conversely if a hunting dog died from injuries inflicted by a hunting animal, such an animal would not have seen a vet. With many hunting dogs, the choice to tail dock or not tail dock such a dog is a personal one, not dictated by any breed standard. The absence of registered tail docked breeds injuring their tails during hunting may be due to the risk of injury being reduced by tail docking.

Risk of injury by breed

The twenty highest-represented breeds in this study were placed in order of which suffered the most injuries relative to the total number of dogs of that breed seen by clinics. Of those twenty breeds, six were traditionally tail-docked. This indicates two things; one, dogs which are presumably tail docked are still suffering injuries, showing that tail docking does not reduce the risk of tail injury to zero. Secondly, plenty of non-traditionally tail docked dogs are injuring their tails, demonstrating that tail docking as a method of preventing tail injury is inconsistently applied, and not necessary applied to those dogs which tend to suffer injury the most often. However, the docked breeds could be higher on the list were they not docked at all, but it is impossible to determine from this data. The data shows that not only undocked individuals belonging to traditionally docked breeds are at risk of injury – a great many dogs, some of the most popular breeds and therefore most numerous, never have their tails docked and do in fact still suffer injuries to them. In order to prevent tail injury on a large scale then tails of all breeds would need to docked, particularly Labradors, pig dogs, pit bull terriers and crossbreeds, all of which are both numerous and have a higher incidences of tail injury (1.39, 1.32, 1.25 and 1.17% respectively) than the average (0.9%). Despite the welfare implications of the risk of injury when leaving these dogs intact, nobody is lobbying for traditionally undocked breeds to have their tails docked. The data supports the earlier assertion that the welfare argument for tail docking to prevent injury is weak and inconsistently applied.

Cause of injury by presumed use

Labradors (including crosses, labradoodles etc), Huntaways (including crosses) and pig dogs were well represented breeds in this study. Generalizations were made regarding the use of these dogs as pets, farm dogs or hunting dogs respectively, based on the breeds most likely to injure their tails in farming and hunting activity, and based on the most popular breeds. The types of injuries each of these three breeds suffered give some justification for their use in representing utility. It is assumed that the majority of Labradors in New Zealand are used as pets, though they do have uses in hunting and are often used as working guide dogs. Huntaways are widely used as working farm dogs. Though "pig dog" is not technically a breed, this was the breed specified for 23 individual case dogs (3.7%) in the study. When dogs are separated out by their assumed use, sensible differences can be seen in the number of hunting and farming injuries. All three of the dogs identified here are traditionally undocked according to NZKC standards. Labradors never injured their tails in farming or hunting activities, which means the assumption that they are used as pets most of the time may be reasonable. Huntaways injured themselves hunting and farming, but never in attacks or during exercise. Pig dogs virtually only injured themselves in hunting accidents, though they were known to injure their tails in a door. Both farming and pet dogs appeared to injure themselves in accidents as well as in incidents with vehicles.

This data mainly demonstrated that tail injuries are not exclusive to dogs used for working and hunting – all three types of dogs injured themselves in doors for example. It did show that pig dogs are more likely to injure themselves hunting that in any other activity, but perhaps a dog identified specifically as a pig dog does little else besides hunt, is not taken out for other forms of exercise or invited inside, so it has no chance to injure its tail in other ways.

Case control study

If tail docking was more of a risk in hunting and working dogs, we might expect to see the risk for tail injury in rural dogs would be higher than that for urban dogs. The results of this study show the odds ratio for tail injury in rural dogs is only slightly higher than that of urban dogs. This small difference may be accounted for by the higher number of working (but apparently not hunting) injuries that do not appear to occur as often in urban settings. The urban/rural section of this study shows that vehicle accidents are more common in rural dogs also, and these were a frequent cause of injury in the total population.

The cut-off point where a vet clinic was considered “urban” or “rural” may have not been very well defined by the inclusion or exclusion on the list of New Zealand’s most popular urban areas. If so this will have influenced the findings of the case control study.

A significant association (P=0.003) was found between tail injury and possession of a tail (not belonging to a tail docked breed). The odds ratio for this risk of exposure was 6.15 (95% CI 5.83, 6.50) meaning a dog presumed to have an intact tail was about six times as likely to injure their tail as one belonging to a traditionally docked breed. This is consistent with the finding that only 15.4% of tail injuries were in tail docked breeds. As mentioned we cannot know for sure if this low number is because of tail docking itself, because we are not comparing docked and undocked individuals of the same breed.

Rural versus Urban clinic findings

As mentioned, the method for determining whether a clinic was rural or urban was not incredibly scientific and there may be problems with the assumptions made here.

However, some sensible findings are revealed, such as the low number of farm work injuries in “urban” clinics. Conversely, more urban dogs were injured in hunting activities, which is counter-intuitive.

The higher total number of dogs seen at rural practises seems surprising as the population would presumably be higher in urban areas, but this may be a reflection of the wide area a “rural” clinic is servicing.

The stark difference between the number of traditionally docked breed dogs in rural and urban clinics is interesting. It could be the result of a much higher number of pedigree breeds in urban centres. Due to the perception of hunting and farm work as particularly likely to cause tail injury, one might assume that a traditionally docked breed would be more common in a rural setting. It appears that perceptions of tail injury do little to influence which breed a rural dog owner will select.

Docking was a much more common cause of injury in the urban population, which is not surprising if we consider that a larger proportion of urban dogs belong to tail docked breeds.

A higher number of door related injuries in urban areas suggests that urban dogs might be more likely to be allowed inside, which puts them at risk of getting a tail caught in a door. Vehicle injuries were more common in a rural setting, despite the assumption that urban areas are presumably busier with traffic. This could be because dogs in rural areas are not contained in the same manner as urban dogs, because the distance between neighbours and a lack of dog control officer presence means this is not always necessary. This puts them at risk of getting out and onto the road.

Amputation was more than twice as likely for a rural dog suffering a tail injury. This could merely be due to the nature of injuries suffered in a rural setting, but could also possibly be the result of differing cultures and perceptions between rural and urban vets. Rural vets may have more experience with large animals, and less experience with companion animals such as dogs. This difference in experience may cause them to suggest a different treatment option than an urban or small animal practise vet might. Given the smaller proportion of docked breed dogs in rural clinics, this apparent willingness to amputate a limb is note-worthy. However, such vets could have extensive experience of docking in production animals which makes them more comfortable with the idea of tail amputation in the canine.

Seasonal trends

Seasonal trends were not revealing. If tail injuries were primarily the result of working or hunting activity, seasonal effects of such activity may have been observed, but there were no such trends found in this study.

Demographics

More dogs injured their tails at about two years of age than any other time. This is the age at which a dog tends to mature so this may just be that young dogs are more energetic, clumsy or likely to take risks that an adult dog might not. Tail injuries appeared to decrease as the population aged, which could be a reflection of decreased activity levels of older dogs. This result could also merely be a reflection of dog population demographics generally, older dogs are less numerous in the population because the increased age makes it less likely that a dog is alive to injure its tail. The sex ratio was close to even as could be expected.

The usefulness of data mining and the SQL script

The script returned a very useful and almost complete data set. The software package will have required the input of breed, age and sex as part of normal procedure so it was rare for this information to be missing. Occasionally there were a litter of puppies under one appointment so that sex was not collected and some were also missing birth dates. A handful also had birth dates that resulted in a negative age at the time of injury, presumably this is the result of a typographical error but it is surprising that the software package did not return an error message to the user when a date later than the current one was supplied for birth date. The clinical notes field was useful in determining whether or not a tail injury had occurred but often did not contain specific information regarding the cause of the injury or the resulting treatment.

It is imagined this same SQL script, only slightly modified, could be useful in other veterinary research, particularly epidemiological studies. A major drawback was the amount of processing time required to remove false positives and make this data set useful. The search term “tail” was chosen to have in order to capture any and all tail injuries. There are very few other terms common to the clinical notes of cases in this study. Indeed, even to use terms as specific as “tail injury/injured tail”, “sore tail” or “broken tail” would have meant a loss of a large number of cases. There was a very high rate of information overload, but the upshot of this is that every possible tail injury was captured, regardless of the wording in the clinical notes. Depending on keyword selection, and the number of participants used, this could prove problematic for future studies. However the method was cheap to use, ensured privacy and it was reasonably easy for clinics to carry out the search when provided with instructions.

Another limitation to this study, posed by the free text field of the clinical notes section, is that a great many of the injuries were of an unspecified cause, and to a lesser degree, a number of cases had no treatment specified in the notes. This study works under the assumption that there was no bias in those cases where a cause and/or treatment were not specified, but because of the large number of such cases, it is not certain that this has not occurred.

Response rate

The response rate was much lower than expected. Only 16 of the 108 clinics (14.8%) contacted were recruited for this study. One or two other clinics expressed an interest in participating but did not have the correct software package, or could not update to the correct version for us to trawl their databases. The response rate was expected to be higher given that participation was completed electronically, rather than by questionnaire, and because participants were not asked to offer any personal information or opinions. This low rate may have been a reflection of the need for clinics to upgrade to a newer build of the software before completing the search. Clinics upgrade periodically, so many had the correct version by the time they came to search; for others, this extra step may have been a hassle that prevented them from participating. In future studies, response rate would be expected to be higher as clinics gradually upgrade their software in their own time. It may have also been possible to increase response rate by advising participants that this research was completed in association with the New Zealand Veterinary Association's Companion Animal Society. A participation notice was placed in the Society's newsletter, but some clinics responding to this did not use the appropriate software package.

Because tail docking is a contentious issue, it is possible that there was some bias in those clinics that chose to participate.

False positives

As discussed, there are a number of clinical conditions addressed in the literature review that might initially present as tail injuries because of their symptoms, such as anal gland conditions (blockages and infections) and degenerative conditions such as arthritis or disc herniation. Each of these can result in a dog holding the tail low and favouring the back end or even marked pain response in the tail so may be mistaken for a tail injury initially. The vet's diagnosis was treated as the correct one unless proven wrong in subsequent vet visits.

Lack of individual docking status

The elegant study design of Diesel *et al.* (2010) allowed the authors to draw conclusions about the risk of tail injury dependant on their use, actual tail docking status, wag angle and environment of the individual dog.

The present study contained no survey component so it lacked such information concerning individual dogs. All of the data used was gathered exclusively from the veterinary databases of participating clinics. This meant no information was available on the use of the dog (working/hunting/pet) or the actual tail docking status of the individual. Such information needed to be assumed based on breed alone.

However, the study did not rely on the participation of owners as well as that of clinics. The involvement of owners in the present study would have likely negatively impacted the already suboptimal response rate, and presented additional ethical or privacy issues. By adhering to data mining methods alone, no clinic data needed to be disregarded due to subsequent non-participation from owners. This study used a smaller number of clinics, but gained a greater number of cases over a longer retrospective time period. In addition the method of this study is novel, with an Australasian-based software program utilising a specially-written SQL script. It is thought that a similar method could be used to conduct future veterinary epidemiology research in the region.

This study excluded any tail injuries that were not presented to a vet, and of course excluded any vet clinics that were unable or chose not to participate in the study. It is assumed that tail injuries which do not require veterinary intervention are not so severe, but other constraints such as finances and location may also preclude vet visits when they are warranted. The limited number of vet clinics participating in this study limits its scope and therefore extrapolation to the wider population of dogs in New Zealand is made more difficult and less precise.

Conclusion

Amputation of the tail is a therapeutic necessity in certain situations. Similarly, it is likely that docking a tail reduces its chance of becoming injured, but only when docking does not cause injury. This calls into question the justifiability of tail docking when there are such a small number of tail injuries, and an even smaller number of these result in amputation or partial amputation of the tail. Despite a perception to the contrary, tail injuries are generally easy to treat, usually with a single visit to the vet to obtain appropriate pain medication.

All dogs are capable of injuring their tails, regardless of breed, use and even tail docking status. It does not appear that hunting or working dogs are more predisposed to injuring their tails than other dogs, because more often than not, dogs injured their tails in accidents, most commonly involving doors.

Claims cannot be made for the efficacy of tail docking without comparing separate populations of docked and undocked individuals of the same breed, but because it reduces the amount of physical space occupied by the tail, docking presumably reduces (but does not remove) the risk of many types of injury. However this comes at a welfare cost; not only because the procedure is widespread and considered by some to be painful, but also because docking itself poses a risk of injury. Even if pain is minimal, it appears that the vast majority puppies are docked quite unnecessarily and therefore unjustifiably.

Such findings mean the tail injury prevention argument for tail docking needs to be reassessed and the question arises whether or not tradition and aesthetics are the real reasons tail docking proponents defend the practice. If a ban comes into place in New Zealand, a study similar to this one could be carried out in future to examine the effectiveness of such a ban, and compare rates of tail injury.

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Appendix 1. Permission letter for Vet Clinics (including return slip)

To the clinic manager;

As part of a Master's thesis at Massey University, we are conducting a study investigating the types of injuries suffered by dogs with intact (i.e. not docked) tails, and the risk factors for such injuries. To do this we need to collect data on dogs with tail injuries presented to vet clinics. Diesel *et al*. (2010) conducted a similar study in the UK, where tail docking is banned, so we aim to compare their results with New Zealand data where the practice continues. In the event that tail docking is eventually banned in New Zealand, our findings may be compared with the incidence of tail injuries after such a ban to draw conclusions about whether or not tail docking significantly reduces the risk of injury.

We are seeking veterinary clinics to participate in this study. If you use RxWorks, VL2, VisionVPM or similar database software in your clinic, we would be very interested in enrolling your practice.

What would we ask you to do?

If you agree to enrol, we would ask you to

- Run a keyword search for the term "tail", for the period January 1st 2004 to December 31st 2010.
- Export the results, as well as the relevant clinical records, to an Excel spreadsheet. This spreadsheet will NOT contain any information regarding the owner or clinic, and you are able to observe this for yourself before you send. Information on the dog will include date of birth, breed, sex, and the date and nature of the tail injury.
- E-mail this spreadsheet to us as an attachment.

We would request you to perform this twice: once (in June) to extract data on cases, and once at a later date (August) to extract data on controls.

We will provide clear instructions on how perform these steps. We appreciate that your clinic is very busy and would not expect each search to take more than 15 minutes or so of staff time.

All participating clinics will be placed in a prize draw for an afternoon tea hamper for your clinic staff. As participants you are also entitled to receive a summary of the research upon completion.

If you are willing and able to have your clinic involved in this study, please fill out the slip on the following page and return it to us by fax, or email.

Kind Regards,

Amber Wells, Kate Hill, Daan Vink, and Kevin Stafford, Massey University

Please return the following slip by fax (06 350 5636) or email (animal.amber@gmail.com) to let us know if you are able and willing for your clinic to participate in this study.

☐This clinic (____) will participate in the above described study.

We are currently running ____________________________ (Database software)_______________________(version).

Vision customers circle one: We are/are not able to upgrade to Version 344.12

☐ We would like to receive a summary of this research when complete.

Signed__________________________(clinic manager)____________________(Date)

Appendix 2: Tutotrial for use of VisionVPM provided to Clinics

Appendix 3: List of Traditionally Docked Breeds

(From the Council of Docked Breeds: http://www.cdb.org/list.htm)

Airedale Terrier
American Cocker Spaniel
Australian Silky
Australian Shepherd
Australian Terrier
Bouvier des Flandres
Boxer
Bracco Italiano
Brittany
Cane Corsa
Clumber Spaniel
Cocker Spaniel
Dobermann
English Springer Spaniel
Fell Terrier
Field Spaniel
German short-haired pointer
German wire-haired pointer
Giant Schnauzer
Glen of Imaal Terrier
Griffon Bruxellois
Hungarian vizsla
Irish Terrier
Italian Spinone
Jack Russell Terrier
Kerry Blue Terrier
King Charles Spaniel
Lakeland Terrier
Large Munsterlander
Lucas Terrier
Miniature Pinscher
Miniature Poodle
Miniature Schnauzer
Neopolitan mastiff
Norfolk Terrier
Norwich Terrier
Old English Sheepdog
Patterdale Terrier
Parson Jack Russell Terrier
Pembroke Welsh Corgi
Pinscher
Polish Lowland Sheepdog
Rottweiler
Russian Black Terrier
Schipperke
Schnauzer
Sealyham Terrier
Smooth Fox Terrier
Soft-coated Wheaten Terrier
Spanish Water Dog
Standard Poodle
Sussex Spaniel
Swedish vallhund
Toy Poodle
Weimaraner
Welsh Springer Spaniel
Welsh Terrier
Wire-haired Fox Terrier
Yorkshire Terrier