Rehab the Mind!

Laurie Edge-Hughes, BScPT, MAnimSt (Animal Physio), CAFCI, CCRT,
Four Leg Rehab Inc – www.FourLeg.com

Introduction

The condition known as canine dementia (CD) is also known as canine senility, senile dementia, senile cerebral dysfunction, cognitive impairment, and cognitive dysfunction (Beaver 1999). In humans, Alzheimer's disease is generally characterized by initial decline in episodic memory followed by progressive decline across multiple cognitive domains. Research has contributed in the understanding of its etiology in both human and animal models. Physical therapy techniques, which are currently applied in humans for the treatment of Alzheimer's Dementia (AD), may have a role in the treatment and/or prevention of this condition in dogs.

Behavioral alterations

Older canines, much like older humans, show a variety of symptoms, which can be attributed to a decline in their brain function. Canine cognitive disorder is broadly defined as a host of geriatric behavioral changes which cannot be attributed to any other medical condition (Overall 2000). Four categories of behavioral dysfunctions have been characterized and identified as canine cognitive impairment: impairment in orientation or disorientation in home and yard, impairment in social interaction with changes in social interactions with human family members, decline in house training, and alterations in sleep-wake cycles (Table 1) (Bain et al 2001, Adams et al 2000, Neilson et al 2001). A dog is considered to have an impairment in one of these four categories of canine cognitive dysfunction if it exhibits two or more signs of that particular category at least once a week for one month or longer (Bain et al 2001).

Table 1. Qualification of categories of canine dementia. (Bain et al 2001)[2]

Impairment in orientation • Staring into space • Getting lost in the house or yard • Getting stuck in corners • Standing at the wrong door or wrong part of door to go out • Any other sign logically attributed to disorientation	**Impairment in social interaction** • Decline in greeting owners • Decline in soliciting attention • A change (increase or decrease) in following owners around the house
Impairment in house-training • Started to urinate / defecate in the house without a history of behavioral or medical reason (i.e. incontinence or separation anxiety) • A decline in signaling to go out or use of the doggie-door.	**Alterations in sleep-wake cycle** • Regularly wakes owner at night by pacing or vocalizing • Sleeping less at night • Sleeping more during the day

A more encompassing questionnaire has been produced by Landsberg et al (2012), with similar categories summarized by the acronym DISHA; Disorientation, Interaction

alterations, Sleep-wake cycle disturbances, House soiling, Activity level changes. Table 2 shows the questionnaire. In addition, signs of fear, phobias, and anxiety, which are commonly reported by owners of senior pets, may be analogous to the finding of agitation and anxiety in humans with AD (Landsberg et al 2012).

Table 2. Canine Dysfunction Syndrome Checklist (Landsberg et al 2012)		
Signs: DISHAAAL	**Age First Noticed**	**Score 0 – 3**
D: Disorientation / Confusion – Awareness – Spatial orientation Gets stuck or cannot get around objects Stares blankly at walls for floor Decreased recognition of familiar people / pets Goes to wrong side of door; walks into door/walls Drops food / cannot find Decreased response to auditory or visual stimuli Increased reactivity to auditory or visual stimuli (barking)		
I: Interactions – Social Relationships Decreased interest in petting / avoids contact Decreased greeting behaviour In need of constant contact, over dependent, "clingy" Altered relationship with other pets – less social / irritable / aggressive Altered relationship with people – less social / irritable / aggressive		
S: Sleep-Wake Cycles; Reversed Day / Night Schedule Restless sleep / waking at nights Increased daytime sleep		
H: House soiling (learning and Memory) Indoor elimination at sites previously trained Decrease / loss of signaling Goes outdoors, then returns indoors and eliminates Elimination in crate or sleeping area		
A: Activity – Increased / Repetitive Pacing / wanders aimlessly Snaps at air / licks air Licking owners / household objects Increased appetite (eats quicker or more food)		
A: Activity – Apathy / Depressed Decreased interest in food / treats Decreased exploration / activity / play Decreased self-care (hygiene)		
A: Anxiety Vocalization, restlessness / agitation Anxiety, fear / phobia to auditory or visual stimuli Anxiety, fear / phobia of places (surfaces, locations) Anxiety / fear of people Separation anxiety		
L: Learning and Memory – Work, Tasks, Commands Decreased ability to perform learned tasks, commands Decreased responsiveness to familiar commands & tricks Inability / slow to learn new tasks		

Score: 0 = none; 1 = mild; 2 = moderate; 3 = severe.

Neilson et al (2001) found that castrated male dogs were statistically significantly more likely to develop impairment in orientation than spayed female dogs. The findings also suggested that the processes in the brain responsible for age-related behavioural changes are not different between small and large dogs. They also found that of all dogs 11 to 12 years of age, 28% showed signs of at least one type or category of behavioral impairment, whereas 10% of the dogs showed signs of at least two categories of impairment. Authors of the study also concluded that of all dogs 15 to 16 years of age 68% showed signs of at least one type or category of impairment, whereas 35% of the dogs showed signs of at least two categories of behavioral impairment (Overall 2000). In another study, Bain et al (2001) found that dogs which exhibited some of the signs of any particular category of behavioral dysfunction were likely to display a greater severity of those signs or additional behavioural impairments 6 – 18 months later.

In addition, other authors have demonstrated that geriatric dogs show deficits in memory such as forgetfulness of learned behaviours and habits (Beaver 1999). Other age-related learning dysfunctions have been observed in reversal learning, allocentric spatial learning, spatial learning, spatial memory and object recognition memory (Table 2) (Adams et al 2000). Procedural learning and memory (i.e. where to get food, signs that food is being dispensed and behaviors required to get food) and object discrimination (animal is able to learn which one of two objects hides a treat) are skills that are not affected by aging processes (Adams et al 2000).

Table 2. Definitions of learning disabilities that are age-sensitive in the canine
(Adams et al 2000)

Reversal learning:	Similar to object discrimination but after the animal learns one behavior stimuli, then the reward is reversed (i.e. the treat is put under the other object) and the animal must re-learn which object to select in order to be rewarded.
Allocentric spatial learning	The ability to locate an object on the basis of the position of the visual object in reference to a known landmark.
Spatial learning	The ability to locate an object in space.
Spatial memory	The ability of maintaining a limited amount of information for a short period of time in order to re-use a learned behavior.
Object recognition	Using non-matching objects, the dog able to be trained to choose a novel object amongst a choice of familiar objects.

Pathologic changes
Aging dogs show several processes of deterioration in their brain, which are similar to humans and other animal models of Alzheimer's Dementia. ß-amyloid plaque deposits, and neurofibrillary tangles composed of an abnormally hyperphosphorylated protein, tau, have been identified in brains of older dogs (Beaver 1999, Neilson et al 2001, Araujo et

al 2005, Uzun et al 2011), with the hippocampus and cerebral cortex being primarily affected (Overall 2000, Cotman et al 2002). However, multiple regions of the brain gray matter exhibit a profound neuronal loss (Uzun et al 2011). It has been determined that the amount of ß-amyloid deposition in the brain can be correlated with the severity of cognitive dysfunction in dogs (Overall 2000, Cotman et al 2002).

Ventricular dilation, thickening of meninges, vascular changes, a decrease in cerebral volume, as well as an increase in oxidative stress with a reduction in mitochondrial function, and poorer metabolic strategies for mitigating oxidative stress have been identified as characteristic in dogs with canine dementia (Overall 2000, Araujo et al 2005, Cotman et al 2002, Milgram et al 2002). Other studies in dogs have found a correlation between cholinergic tone and memory impairment and dementia (Beaver 1999, Araujo et al 2005). Cotman et al (2002) proposed that the oxidative damage observed in dogs exhibiting signs of CD is likely to play a central and pivotal role in the evolution of the cascade of events that result in canine dementia and cognitive impairment. The authors suggest that since the brain utilizes the greatest amount of oxygen in the body, the oxidative damage observed is likely to begin early in life, but this pathological change is unlikely to induce a substantial neuronal dysfunction until late in life (Cotman et al 2002).

Neuromusculoskeletal function in Alzheimer's Disease

Franssen et al (1999) found that human patients affected with Alzheimer's disease show significant delays in activation of postural responses to perturbations. These patients demonstrate a slowing of gait and movement (described as a "cautious gait") associated with a real or perceived instability. This can be attributable to a loss of balance, and equilibrium, and/or limb co-ordination (Franssen et al 1999, Pettersson et al 2005). Affected humans also suffer from subtle changes in sensorimotor function. These losses and deteriorations result in anxiety, insecurity, and reduction in physical activity, and loss of social contacts (Franssen et al 1999). Falls and injuries commonly afflict Alzheimer's patients, and can lead to premature loss of function, deconditioning, fractures, other illnesses as a result of injuries, and early institutionalization (Franssen et al 1999, Pettersson et al 2002, Pettersson et al 2005). Additional motor functional performance deficits other than gait alterations may be present in humans with mild stages of Alzheimer's (Pettersson et al 2002). Patients with Alzheimer's have been found to be significantly less active than healthy subjects of similar ages, have impaired postural control, and had the tendency to cease activities that placed more demands on initiative, interacting with others, and planning (Pettersson et al 2002).

Lifestyle in the prevention of Alzheimer's disease

Human and animal studies have reported lifestyle factors that could be considered to be preventative for the development of AD. In humans, there seems to be a correlation with a lower risk of development and/or late onset development for AD in those with higher levels of education, and those with varied intellectual, physical, recreational, and social activities (Uzun et al 2011). Interestingly, social network size also seems to play a role in preserving cognitive functioning.

Physical exercise is an accepted neuroprotective strategy. Exercise has been known to modify brain function in humans (Sutoo and Akiyama 2003). Although the mechanism by which it does so is unknown, compared with no exercises, physical activity was associated with a lower risk of Alzheimer's disease and dementia (Sutoo and Akiyama 2003). There is an inverse relationship between physical activity and ß-amyloid deposits in mice brains (Nelson 2005). Rodent & human models demonstrate that not only is lifelong physical activity a preventative strategy to reduce the likelihood of developing neurodegenerative disease, exercise has also been shown to be effective as an intervention in aged populations at risk for or suffering from Alzheimer's disease (Stranahan et al 2012). The same review paper reported that in mice, exercise in the form of wheel running, can reduce plaque accumulation and reverse the increase in tau phosphorylation, and may ameliorate learning deficits.

It has been demonstrated that anti-oxidants can delay age-related cognitive decline in humans and improve mental/behavioral performance in aged rodents (Milgram et al 2002). Milgram et al (2002) provided evidence demonstrating that age-dependent impairments in dogs can be at least partially reduced by supplementing the diet with a complex mix of anti-oxidants and mitochondrial enzymatic co-factors. Results of this study highlighted a superior performance in oddity discrimination tasks in old animals receiving an anti-oxidant enriched diet when compared to control dogs. The antioxidants utilized in the study were vitamin E, vitamin C, alpha-lipoic acid, L-caritine, beta-carotene, and fruits and vegetables (spinach, tomato, grape, carrots & citric pulp).

Other treatments for canine cognitive dysfunction syndrome include ginko biloba (which may improve memory loss, fatigue, anxiety and depression), and high intake of fruits and vegetables (that have antioxidant and anti-inflammatory properties) (Landsberg 2005). As well, omega 3 fatty acids (which promote cell membrane health and reduce inflammation), L-deprenyl (a monoaine oxidase-ß inhibitor which limits free-radical loading) and anticholinesterase drugs (which enhance cholinergic function) have been reported to aid in aged dog cognition (Landsberg 2005, Ikeda-Douglas et al 2005). However, in regards to nutritional support for this problem, the greatest amount of research has been in anti-oxidant therapy.

Physiotherapy treatment suggestions for canine dementia

In human medicine, Alzheimer's patients are examined by physical therapists, occupational therapists and speech and language therapists, who evaluate the practical skills of the patients (Pettersson et al 2005). And rehabilitation facilities implement cognitive activities, which may delay the clinical onset of Alzheimer's disease (Olazaran et al 2004). Activities might include exercise, socialization, sensory stimuli, cognitive training, music, and prescribed sleep-wake cycles.

Geriatric canine exercise classes could be established in canine rehabilitation clinics that might include basic obedience training, scent discrimination tasks (i.e. finding a treat under one of three or more cups), and obstacle courses that require the animal to follow their owner through a course (i.e. much like a safety-modified agility course). Swimming or underwater treadmill walking for example could be great modes of cardiovascular

exercise that do not impart the same concussive forces on potentially arthritic joints of older animals. Physical activity might be a useful strategy in therapeutic management by delaying loss of neuromusculoskeletal functioning (posture, balance, co-ordination), motor performance and activity levels. Safe balancing exercises (i.e. standing on a low-to-the-ground balance beam), coordination training (i.e. backing-up as an exercise), and postural exercises (i.e. abdominal muscle training / facilitation in standing) could all be incorporated into a therapy session, group exercise session, or home program. Human studies have found benefits with Salsa dancing, Tai Chi and other mind-body exercises (Abreu & Hartley 2012, Lam et al 2012). The benefit of a group program could be that it incorporates socialization and interaction, which are known to be beneficial for people with AD.

Owners could be advised of the benefits of cognitive training and how to challenge their dogs at home (i.e. hide and seek games with the owner or toys or treats). These techniques could be used as both preventative or after onset of dementia. May commercially available brain-games are now on the market for dogs. Owners could be advised to try working on one of these puzzles with their dogs on a regular basis. Food toys that require pushing, pawing, batting, or rolling the toy to release food (i.e. such as a Kong stuffed with treats) may help the older dog to be active, alert, and engaged in an activity. Why not teach the old dog a new trick? There are several books that describe tricks to teach dogs. Owners may simply need encouragement to engage in these activities.

Exposure of mice with Alzheimer's disease to an enriched environment reduces cerebral ß-amyloid pathology versus mice in standard conditions (Nelson 2005). Brain functioning can also be positively affected in demented patients by tactile stimulation and 'unisensory stimuli techniques' (such as bright lights) (van Dijk et al 2005). Enriching a dog's environment might include educating dog owners on the importance of new toys, walks in different areas or in areas with plenty of canine-appealing odours, interaction with humans or other animals and/or use of a seniors-doggie-daycare facility on a semi-regular basis. Tactile and sensory therapy for canine dementia could include massage or other sensorimotor tactile stimulation techniques (i.e. zig-zag petting, clapping or tapping the animals body, brushing against the lay of the hair, manually compressing or distracting the joints).

Maintaining a day-night cycles may also improve the sleep-wake cycle. Spending time outdoors during daylight hours, and/or leaving blinds open when the owner is away at work, may help to normalize the dog's circadian rhythm. Alternately, light therapy during the day could be administered utilizing Light Emitting Diodes (i.e. SAD lights) in a therapeutic setting for selected periods of time. If able, more daytime activities (interactive sessions, outings, play, food toys, walks, etc) will help to encourage better sleep at night.

Conclusion

Physiotherapy is not likely a treatment option readily thought of by traditional veterinarians for the management of canine cognitive disorders. Concurrently, animal

physiotherapists may not even realize how their skills could benefit this potential patient group! However, the animal physiotherapist could prove to be a useful resource for the care of the older dogs in both the treatment and prevention of canine dementia.

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