POTENTIAL SUITABLE METHODS FOR MEASURING THE EFFECTS OF ANIMAL-ASSISTED ACTIVITIES AND THERAPY: A REVIEW

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Dogs are companions of humans since time beyond memory and their use in rehabilitation processes is increasingly frequent. Dogs can be used for animal-assisted activities (AAA) as well as animal-assisted therapy (AAT). The effects, however, have not been fully demonstrated, reasons for this including difficulties in providing evidence of positive action. According to previous studies, there is a decrease in heart and respiratory rate, blood pressure reduction, more positive mood as well as warming of muscles, which promotes relaxation of spastic areas. Regulation of hormone levels might also occur as a result of AAA/AAT. Indeed, increases in oxytocin levels and decreases of cortisol have been found. However, a unified methodology for clear measuring the entire impact of AAA/AAT on patients is missing. This survey evaluated different methods for measuring the effects of AAA/AAT, with results showing that the most suitable ones, selected on the basis of the effect of rehabilitation, comprise thermography, spectral analysis of heart rate, electromyography (EMG), polyelectromyography (PEMG), and blood sampling. Because AAT making use of dogs has not yet been recognized as an official method of treatment, it is very important to find out objective means to evidence its beneficial effects.

Highlights:
- Using dogs for AAA/AAT has a positive effect on client's mental as well as physical condition
- AAT promotes motor functions and helps restore appropriate movement patterns
- Possible methods to measure the effect of AAA/AAT are thermography, spectral analysis of heart rate, electromyography (EMG), polyelectromyography (PEMG), and blood sampling

animal-assisted therapy, dog, thermography, EMG, PEMG, spectral analysis of heart rate, oxytocin, cortisol

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INTRODUCTION

The relationship between humans and dogs has been shaped over thousands of years. Their interactions have been positive, not only from a practical point of view, but also from an emotional one. An extraordinary ability to communicate and understand each other thus has developed in both species over time (S i l v e i r a et al., 2011). For this reason, the dog–human interaction has been increasingly taking place in rehabilitation processes in the form of animal-assisted activities (AAA) as well as animal-assisted therapy (AAT).

Animal-assisted activities, animal-assisted therapy, and positioning

AAA are exercises that are not specifically given a therapeutic target and are mainly used to activate persons who are, for example, in a hospital or retirement home. However, their positive effects are many, mostly based on mobilization, activation, and happiness. On the other hand, AAT has a clear therapeutic target. It has been included as a complementary therapy within several other treatments, such as speech therapy, physiotherapy or occupational therapy. Objectives of AAT

are set in collaboration with doctors and other medical personnel according to the condition of the patients.

Another widely practiced form of AAT uses the so-called positioning (Kalinová, 2006). Positioning is an AAT method in which a client benefits from physical contact between her/him and the dog with the animal placed in various relaxing positions and staying there for several tens of minutes. This method is among the most effective activities in AAT (Lejčarová, Skálová, 2009). Positioning acts on the mental and physical condition of the client in a positive manner. During the process, there is warming and relieving of spasms (Benešová, Zouharová, 2007). The activity to relax and warm up the client makes use of the dog's body temperature which is higher compared to that of human – around 38°C. In association with the action of heat on the body, positioning provides a very good basis for subsequent massage or speech therapy intervention (Lejčarová, Skálová, 2009).

The method is used in physiotherapy as well; it is among the therapeutic means of rehabilitation nursing, which focuses on the prophylaxis of secondary damage. Periodical and intense positioning is performed in patients who suffer from reduction or loss of mobility, and impaired sensitivity of specific parts of the body. Changing the position encourages the emergence of various stimuli that can help sensory and thus motor functions to restore. Positioning makes use of accurately predefined positions. It helps relieve the strain of the skin and improves blood circulation of the body part. It is carried out depending on the identified goal, which may be to regulate the muscle tone, to prevent contractures, pressure sores, pneumonia and articular deformities from emerging, to improve circulatory function, and to limit the risk of peripheral neuropathy. Furthermore, it eliminates pain and improves vigilance, attention, and general mental condition (Kolář, 2009). Any change in the position of the segment is associated with changes in muscle tension, which can be used for therapeutic effects. Stimulating by tactile contact along with the proprioreceptive afferents resulting from the position of the body and its individual parts creates a specific flow of information entering the CNS, which can be exploited for a therapeutic intervention in the controlling CNS function (Velé, 2006).

Not only limited to positioning, there are many positive effects as a result of the interaction between dogs and humans that are purely of physiological nature. Specifically, some of the found effects of AAT (using dogs) are lowered blood pressure, heart rate, and stress levels, as well as an increased social interaction and emotional well-being of the client. The action of the animal is also influencing the reduction of the physical and mental pain that the client perceives (Sobo et al., 2006), reducing respiratory rate and enhancing mood. After the intervention, clients feel more energy (Coakley, Mahoney, 2009). AAT lowers blood levels of catecholamines – adrenaline and noradrenaline (Cole et al., 2007). AAA are reducing depression in patients and increasing arterial oxygen saturation (Orlandi et al., 2007). AAT using dogs reduces the level of anxiety in patients with various psychiatric diagnoses as well as in those with physical diseases, including illnesses that are impossible to cure (Barker, Dawson, 1998; Cole et al., 2007; Orlandi et al., 2007). Positioning in AAT making use of dogs causes the spasms to relieve, salivation to reduce, extremities to warm up, and deeper breathing (Benešová, Zouharová, 2007). A significant increase has also been demonstrated in the levels of β-endorphin (an analgesic in the body to numb or dull pains) and oxytocin. The relevancy of an increase in the levels of this last hormone has been stated by studies showing an improved potential for wound healing as a result of increased levels of released oxytocin following positive social interactions (Gouin et al., 2010). Indirect positive effects on the central nervous system have also been found due to an increased level of prolactin after AAT (Gregg et al., 2007). Additionally, there is also evidence of positive changes in dopamine levels (Rice et al., 2011) and phenyl ethylamine in both humans and dogs during their interaction. Besides, human cortisol levels have also been found to decrease simultaneously (Odendaal, 2000).

During the AAA/AAT visits, dogs are not selective in regards to the client, do not discriminate against them and are neither offending or judging them, thus supporting the creation of these intimate relationships. Dogs' presence in the interaction with humans is mostly friendly and harmless, resulting in the generation of an open and comfortable environment among the patients. This effect allows the use of dogs with patients with varied kinds of diagnoses. Dogs can be included in therapies with patients suffering from cerebral palsy, those with Down syndrome, epilepsy, autism (Nimer et al., 2007), hyperactivity, and schizophrenia (Barker, Dawson, 1998). In such cases, dogs are supportive chiefly through their emotional support and often serve as a bridge of communication between the patient and the therapist (Petrů, Karásková, 2008).

Because of the mentioned wide range of possible uses of dogs in therapy, it is necessary to find potentially suitable methods for measuring the specific positive effects of AAA/AAT in humans. Currently, the evaluation of the outcomes of AAA/AAT has been mainly conducted with scales previously used in fields like psychology, psychiatry or speech therapy. The effect on the internal functions, however, proves very difficult to evaluate. It is therefore needed to find a method that will be able to give specific insight on the relationship and effects of AAA/AAT on joint mobility, muscular potential, mood, blood pulse, blood pressure, seizures, and changes in the levels of stress hormones.

The aim of this article is to build a real overview of available methods that would serve this purpose. Selection and practical use of these methods will be subject to further exploration.

Objectification methods for assessing the effects of animal-assisted therapy with dogs

Thermography. In AAT using dogs, thermography can be used for the objectification of the vasodilatory effect with hyperemia in positioning, when the warmth generated by the dog acts on the human body. Positioning is practiced in clients with various motor disorders with which changes in blood flow through the affected part may be associated (Kolář, 2009).

Vasomotor disorders can be caused by damage to sympathetic innervation, among others. This may result in increased vasoconstriction with hypothermia in the denervated area, as well as vasodilation with increased temperature in the area if sympathetic vasoconstrictor activity is lost (Jesenšek-Papež, Palfy, 2012). In diseases of the central nervous system such as apoplexy and brain or spinal cord injury, the lack of movement results in negative physiological and biochemical changes in all the organs and systems, including the circulatory system. In patients with spinal lesions (the chronic phase), hyperactivity of the spinal sympathetic system may occur, causing vasoconstriction. Circulatory instability is compounded by the fact that there is an affected activity of muscles of the lower extremities that normally serve as a muscle pump and facilitate venous return (Czell et al., 2004). Decreased blood flow may occur even in hemiplegic limbs of patients after apoplexy. This is probably due to changes in the autonomic control of the vasomotor tone by lesions in the sympathetic system (Wanklyn et al., 1994). Lower limbs blood flow decreases during aging. This fact is associated with an increase in the activity of the sympathetic nervous system (Seals, Dinenno, 2004).

As shown in Table 1, it is assumed that during positioning the heat transmitted by the dog acts on the client described as by Kalinová (2006). Heat causes vasodilation with hyperemia at the site of application and there is an increase of blood flow in the skin and muscles. Heat can be distributed even deeper into the body. Thermography is capable of recording these changes.

Spectral analysis of heart rate. In AAT using dogs, the effect of reducing mental and physical signs of stress has been widely described (Heinrichs et al., 2003; Sobo et al., 2006; Cole et al., 2007; Orlandi et al., 2007). Since the spectral analysis of heart rate is capable of assessing stress levels as well as the effect of different relaxation techniques, it can be used to evaluate the outcomes of AAT using dogs, as described in Table 1. However, there are only a few studies evaluating the validity, variability, and reproducibility of the methodology used and the normative data available in the literature very widely.

Electromyography and polyelectromyography. Electromyography (EMG) usually examines a single muscle at a time and is used primarily in neurology (Trojan et al., 2005). The method can be used to discern the causes for increased muscle tone. Diagnosis is based on findings of hypertonus in typical areas and assessment of the clinical picture (Capko, 1998). EMG can be applied in AAT with dogs as well, as hypertonus is caused by dysfunction of the limbic system, in principle through response to stress. Therapy comprises techniques that in general have dampening effect on the motor system and psyche.

On the other hand, polyelectromyography (PEMG), also called surface electromyography, is a method that simultaneously records the potentials of multiple muscles, with this being done in four, eight or possibly up to sixteen muscles (Trojan et al., 2005).

PEMG is used to analyze the function and coordination of muscles in various movements and postures. It allows evaluating the start of activation and the velocity of individual muscles, and the relative interplay of all measured muscles during the movement. It can provide a temporal sequence of one or multiple muscles carrying out the movement or maintaining the posture of the body. Moreover, PEMG can also be employed to determine the onset of muscle fatigue. This method focuses on the evaluation of muscle activity – muscle co-activation as part of the muscle group in complex and simple movements. In addition, PEMG can be used for evaluating therapeutic processes (De Luca, 1997; Süss et al., 2011).

Positioning with dogs acts on spasms relieving (Benešová, Zouharová, 2007). AAT with dogs reduces the level of stress (Sobo et al., 2006), acting on the autonomic system, and, through changes in emotions, on the limbic system as well (Beetz et al., 2012). The limbic system affects the control of cortical and sub-cortical motor system. Action on the spinal level of motor control is generated through tactile stimulation, thus influencing the circuits regulating muscle tone. Relieving the spasm provides the ability to improve muscle coordination, which is reflected on the curve of the PEMG record. A detailed account on the characteristics of both EMG and PEMG methods can be found in Table 1.

Blood sampling. Blood sampling allows the determination of the level of cortisol that is directly related to oxytocin levels. Secretion of oxytocin has the effect of reducing cortisol levels in the blood (Kirschbaum et al., 1995; Ditzen et al., 2009) and cardiovascular reactivity (Gerin et al., 1995). Another effect is the dilation of skin blood vessels, which causes the skin temperature to increase (Uvnäs-Moberg, 1998), blood pressure to decrease, and heart rate to reduce through supporting the effect of catecholamines. Finally, cortisol also has a positive effect on immunity and faster healing.

Table 1. Summary of objectification methods for assessing the effects of animal-assisted therapy (AAT) with dogs

	Thermography	Spectral analysis of heart rate	Electromyography	Polyelectromyography
Applications in AAT with dogs (diagnostics)	pathological vasoconstriction plegia paresis atrophy	pathologies with autonomic nervous system (ANS) dysfunction conditions with increased physical or mental stress cardiological and other internal diseases	muscle hypertonus due to limbic system dysfunction	conditions involving impaired muscle coordination
Followed principle	detection of infrared radiation emitted by human body, recognition of temperature differences in pathological tissue	rating of R-R interval length on ECG waveform with transfer of this information into the image with multiple components in different frequency ranges and creating a performance spectrum, evaluating the activity of sympathetic and parasympathetic nervous system depending on fluctuation in individual zones	sensing bioelectric potentials of skeletal muscles by needle electrode	sensing bioelectric potentials from one or multiple skeletal muscles by surface electrodes
Dog's action on the client	thermal action during positioning	psychological action of dog mediated through direct/indirect contact with animal; psychological influence of dog in positioning	psychological action of dog mediated through direct/ indirect contact with animal; psychological influence of dog in positioning	thermal action during positioning; active training of client's fine and gross motor activities under dog's assistance
Equipment needed	thermal imaging camera, display unit, evaluation computer equipment	microcomputer system for examining heart rate variability, which includes sensing electrode belt, amplifier for continuous ECG recording, and evaluation s oftware	electromyography apparatus with needle electrode, amplifier, and computer for data processing	electromyography apparatus with surface electrodes, amplifier, and computer for data processing
Advantages	capability of detecting thermal effect of dog on body in positioning precise temperature measurements anywhere on body surface possible high speed of measurement and its dynamics	ANS evaluation possible; includes discerning activities of sympathetic and parasympathetic nerves capability to assess the level of stress capability to evaluate the relaxing effect of AAT using dogs possibility of using methods that bring joy to dog as well	evaluating changes in muscle hypertonus caused by responses to stress after the relaxation effect of AAT with dogs	evaluation of changes in muscle coordination after heating by dog, as well as through active training movements with the help of animal
Disadvantages	temperature measurements influenced by physical factors inside room (temperature, humidity, airflow) difficulty of positioning for dog	ANS response to internal and external factors examination results influenced by day phase in examination period, sleep deficit, current psychological mood, pharmacological effects, etc.	inadequate diagnosis of muscular hypertonus in the field invasive testing difficulty of positioning for dog	relatively time-consuming examination requirements for correct location and attachment of electrodes difficulty of positioning for dog

Its increased level causes more irritation; thus, a reduced level gets the patient into a more favourable mood.

In contrast, oxytocin (also called the 'trust hormone') operates in the central nervous system, reducing behavioural and neuroendocrine response to social stress, and having a positive effect on conflict resolution, social relationships, and level of confidence (Honzák, 2009). Emotions like trust, peace, and social stability are very important for facilitating the progress of treatment. According to Nagasawa et al. (2009), a half-hour interaction with a dog causes the levels of oxytocin to increase.

CONCLUSION

According to the available references, AAT using dogs has a positive effect on both the mental and physical aspect of the client. AAA/AAT may affect spasticity, tissue temperature, blood count, respiratory rate or mood, in part via changes in the levels of cortisol and oxytocin. Methods aimed at evaluating these parameters thus appear to be potentially adequate investigation techniques. They include thermography, spectral analysis of heart rate, EMG and PEMG, and blood sampling. AAT making use of dogs is not yet recognized as a formal treatment method, and finding objective means to evidence its effect is very important. This article aimed to map and review available methods to evaluate the outcomes of AAA/AAT. However, further research is needed to test the optimal applicability of each of these methods.

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