SCIENCES OF CHIROPRACTIC (NEUROLOGY AND BIOMECHANICS)

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SCIENCE-BASED VETERINARY MEDICINE (SBVM) AND EVIDENCE-BASED VETERINARY MEDICINE (EBVM)

Throughout their university studies, veterinariansare made aware of the massive scientific foundation that supports theirvocation. They rely on textbooks, professors, and mentors to prepare them for the difficult decisions they must make beginning their first day in practice.Following this education, time and experience aid them in developing an art for the clinical application of those sciences. Treatment of animals,based on thissignificant and sizeablescientific foundation, with the addition of predictable andreliable clinical decisions by the doctor, is science-based veterinary medicine (SBVM).

Today's rapid expansion of clinical research allows the practitioner to take one step further. After arriving at a decision based on his scientific foundation and clinical expertise, he can support that decision with the best available clinical evidence from systematic research. This is evidence-based veterinary medicine (EBVM).[14,54,56,62]Several challenges exist, however. One is, as of 2007 no studies on EBVM had been conducted.[54]Ramsey, in Veterinary Clinics of North America, states,"it seems clear that EBM does benefit human patients, and there is no reason to believe that it would not benefit veterinary patients." The second challenge; research is lacking in many areas of veterinary medicine (VM), and numerous gaps exist in current standards of care where little or no research is available. At these times, even the most ardent supporters of EBVM, would not deny a patienttreatment,solely based on the lack of clinical trials. They would rely on the use of consensus guidelines that were modeled using SBVM. [14,54,56,62]

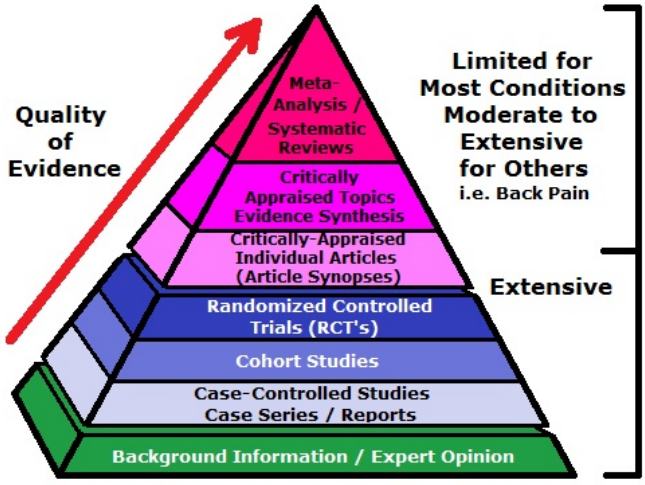


Figure 1

Lack of current, high-level clinical research should never be the quintessential factor in approving or denying any form of treatment. When gaps exist, a preferred method used to fill in blanks and to interpret contradictory or conformity statementsin the literatureis the consensus meeting. In these meetings expertscome together to discuss the contested issues and work toward a practically feasible recommendation.[62]

Animal Chiropractic should be held to the same standards. This session and the next will explore the massive scientific foundation that supports chiropractic as well as the basis of clinical decisions made by the animal chiropractor. This is science-based chiropractic health care (SBCHC).When possible, these sessions will reach into the realm of evidence-based chiropractic health care (EBCHC) by reporting on research that heightens the efficacy of animal chiropractic using meta-analysis, systematic reviews, and randomized controlled studies. Where research is lacking, examination and treatment guidelines have been established by consensus meetings.[16](See Figure 1)Although these guidelines are established for the care of humans, like other forms of health care, it is not implausible that these guidelines would also be appropriate in the equine patient.

EQUINE NEUROLOGY

The nervous system is unique in the way it has evolved throughout time. From the earliest and most simple nerves of the squid, all the way to the complicated nervous system of humans, no part of the brain has disappeared. It just keeps adding parts, but nothing goes away. That is why we can study neurology across the species. You just have to know with what level you are working.[48,51]

The oldest part of the brain is the brainstem, or "lizard brain"; controlling most of the bodies housekeeping chores. Its neurons regulate breathing, heart rate, sleeping and waking. The next layer to develop was the "mammalian brain". This

houses parts such as the amygdala, hippocampus and thalamus. Most of its function centers around what some researchers call the four f's; fighting, feeding, fleeing, and...reproduction. It also processes emotions and memories and is a control tower for the senses. The last layer is the "human brain'" which adds the cerebral cortex, basal ganglia, limbic system and the prefrontal cortex.[46,50] The horse is somewhere in between, with a moderate cerebral cortex and no prefrontal cortex. When studying human versus horse brain function you just have to remove the functions of the prefrontal cortex. It is important for executive function; relating to abilities to differentiate among conflicting thoughts, determine good and bad, better and best, same and different, future consequences of current activities, working toward a defined goal, prediction of outcomes, expectation based on actions, and social "control" (the ability to suppress urges that, if not suppressed, could lead to socially unacceptable outcomes).[7,36]When a horse doesn't like you he kicks or bites. Most humans refrain from biting and kicking until they analyze the situation first.

Functional Neurology

Most of the knowledge we have today about the firing of nerves was based on studies of spinal motor neurons in the 1950's. The neurons integrate synaptic activity by firing at a threshold, creating an action potential.[8,24]Studies from the 1970's revealed that neurons operate under much more complex situations via a variety of forms of chemical synaptic transmission, electrical coupling through gap junctions and interactions through electromagnetic fields. They can also be modulated by neurohormones and neuromodulatorssuch as dopamine and serotonin.[15]With this came a new understanding of the functional interconnectivity of neuron systems and new functional approaches to treatment of nervous system dysfunction.

Central Integrated State of a Neuron System

A neuron fires when there is summation of its presynaptic neuron pool. The central integrated state of a neuron is the total integrated input received by the neuron at any given moment and the probability that the neuron will produce an action potential. A pyramidal neuron in the visual cortex may have up to 12,000 presynaptic connections.[17] Firing requirements can demand complex arrays of presynaptic patterns such as the 'and/or' gated neurons of the motor cortex. 'And' pattern neurons only fire an action potential if two or more specific conditions are met. 'Or' pattern neurons only fire an action potential when one or the other specific condition is present.[9]The central integrated state of a functional group of neurons can be defined as the total integrated input received by the group of neurons and the probability that group of neurons will produce action potentials.[7]

Transneural Degeneration

The central integrated state of a neuron or neuron system is regulated by three basic activities: one, the exchange of oxygen and carbon dioxide, two, adequate nutritional supply (glucose), and three, the frequency of firing of the neuron. Firing of the neuron results in the stimulation of immediate early genes within the neuron that stimulate DNA transcription and the production of necessary cellular components such as proteins and neurotransmitters. Proteins have a multitude of functions in the neuron including neurotransmitter production, intracellular signaling, and enzyme production. In situations where the neuron has had inadequate supplies of oxygen, glucose or stimulus, the manufacturing of protein is down-regulated. This process is called transneural degeneration.[7]

When nerves are irritated they facilitate in an effort to maintain function.[22]As a protective mode, this, and/or early transneural degeneration, changes the presynaptic neuron in an attempt to make it fire easier and more frequent. Long term facilitation can damage or kill a cell. A healthy way to signal faster is by plasticity. (See Figure 2)

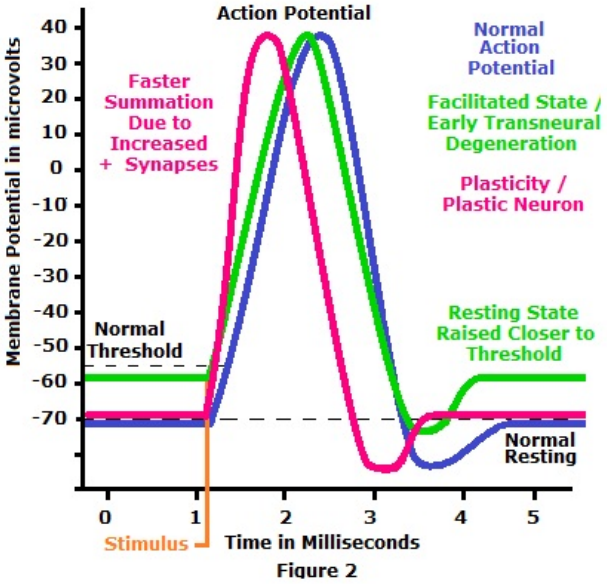


Figure 2

Plasticity

Many nerve synapses, particularly in the brain, are constantly changing. They are dependent on the activation stimulus they receive. The neuroaxis changes its physiological function in response to stimuli from its external and internal environments. Neural plasticity refers to the way in which the nervous system responds to the stimuli and adjusts for future outcomes based on previous responses.[36]In essence; it is the ability of the nervous system to learn.[35]Synapses reorganization in a way in which those that receive more stimulation become strengthened and those that receive less stimulation become weakened.[33,39]Well used pathways sprout axonal and dendritic terminals creating additional excitatory synapses that increase the rate of summation and allow a nerve to fire faster and more frequent. (See Figure 2) Plasticity is enhanced in young animals with an immature cerebral cortex.

Constant and Non-Constant Neural Pathways

Neuronal systems must receive stimuli to stay healthy, but some systems do not work all the time. The cortical cells of vision are constantly stimulated while the horse is awake, but what about the periods of sleep. These are non-constant neural pathways. They are maintained in a healthy central integrative state by activity and stimuli generated via the thalamus. This activity arises from receptors that detect the effects of gravity and constant motion. They are the muscle spindle cells, golgi tendon organs and joint capsule position mechanoreceptors of midline structures such as the vertebral and costal motion units. These receptors never stop working and are the constant neural pathways. The other constant neural pathways are parts of the vestibulocerebellar system and pacemaker type groups of cells found in the heart, thalamus and basal ganglion. All other receptor systems are non-constant in nature.[7,36]This is why one can say that, by far, the greatest amount of afferent receptor activity (over 90%) arises from the mechanoreceptors of the periphery; and mostly by muscle spindle cell activity.

Output is dependent on input, and the greatest and speediest way to change the neural motor units of the entire horse is to stimulate and manipulate afferent receptors from the spine and other core structures through the constant neural pathways.

Neurology Fact Summary

Fact 1: Equine and human neurology are easily studied side by side, as long as you know what parts of the brain are different.

- The equine lacks executive function such as the ability to differentiate among conflicting thoughts, determine good and bad, better and best, same and different, future consequences of current activities, working toward a defined goal, prediction of outcomes, expectation based on actions, and social "control".

Fact 2: Function neurology grew from our new understanding of the functional interconnectivity of neuron systems.

- Neurons operate under complex situations via a variety of forms of chemical synaptic transmission, electrical coupling through gap junctions and interactions through electromagnetic fields.

Fact 3: The health, or central integrative state of a neuron, is determined by two factors:

- it must receive oxygen and glucose to convert to ATP, and
- it must work; which is dependent on the frequency of firing (FOF)of its presynaptic pool.

Fact 4: When the FOF of presynaptic neurons is decreased, the neuron may undergo transneural degeneration When the FOF is decreased enough, the nerve may not fire, creating up and/or down-stream dysfunction (diaschisis).

Fact 5: Synapses reorganize in a way that those that receive more stimulation become strengthened and those that receive less stimulation become weakened (plasticity). In essence, neuronal pathways learn and adapt.

Fact 6: Constant neural pathways are responsible for maintaining the health of the nervous system, hence, the health of the horse. These pathways are driven by the muscle spindle cells, golgi tendon organs and joint capsule position mechanoreceptors of midline structures such as the vertebral and costal motion units.

Fact 7: Output is dependent on input, and the greatest and speediest way to change the neural motor units of the entire horse is to stimulate and manipulate afferent receptors from the spine and other core structures through the constant neural pathways.

BIOMECHANICS

Biomechanics has been described as the application of mechanical laws to living structures. Back and Clayton differentiate this from biokinetics, the study of the forces responsible for the movement of living organisms.[6]As a chiropractor, I would like to expand on both. Biomechanics is the study of the structures of movement in a living being, such as a horse, and the study of the physiological consequences of that movement. These consequences can range from increased heat due to friction, to increased oxygen usage in the tissues, to afferent neural patterning throughout the nervous system. The function of good mechanics is to allow the horse to move and function with as little stress as possible, using as little energy as possible. Poor mechanics result in unnatural stresses on the bones and soft tissue and leads to lameness.[55]

Motion Units and Spinal Mechanics

The most basicconstituent of biomechanics is the motion segment, or motion unit. This is comprised of two articular structures and everything in between. A vertebral motion unit is two adjacent vertebrae and all the structures in between.[49,65] (See Figure 3.)These additional structures are often overlooked when the movement of the bones is studied. But

thesestructures make up the core of the horse and are not only responsible for movement and gaits, but for other functions such as core stability, increased respiratory capacity[69], and afferent stimulation of millions of mechanoreceptors for up-stream constant neural pathway corridors.[7]

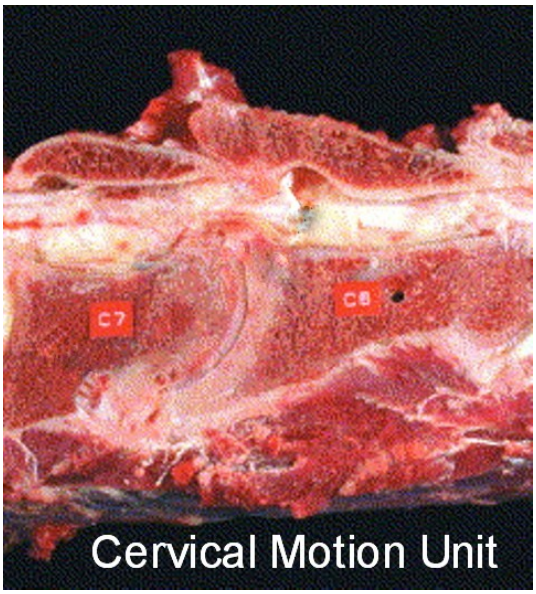


Figure 3

Equine Biomechanical Mechanisms

The horse has four major biomechanicalsystems; the stomatognathic system, the bow and string, initiation of movement (engagement) and the stay apparatus. Inefficiencies in any of these will create unnatural stresses in the involved structures. Left untreated, they will always lead to pathology (lameness). And likewise, lameness left untreated will always lead to biomechanical abnormalities. If disrupted, it is important to restore the systems as soon as possible. Left untreated, compensatory patterns of movement can become plastic, making restoration to normal more difficult. And the longer the afferent stimulation is disrupted, up-stream changes will occur in all systems, both biomechanical and visceral.

HISTORY OF MANIPULATION

Written records of manipulation go back to 300BC. All cultures used it for health care; Chinese, Indian, Greek, Roman, Byzantine, Cretan, Arabic, Turkish, Spanish, Italian, French, German, Bohemian, Tahitian, Colombian, North American Indian and manymore.[28,29,41,61,63,64,70]Manipulation was a universally accepted form of health care and its usefulness was not seriously questioned until the 18th century.[41]Johan Schultes, who died in 1645, was the last author to teach manipulation as part of regular medicine.[4]Although the reasons for this are not clear, several theories have evolved; from the fear of contagious contact to the fear of repercussions of manipulatingtuberculosis caries in the spine.[4,41]One thing is sure, medicine was becoming professionalized, and anything traditional was associated with lay practitioners and rejected. The surgeons condemned the practices not because of any real objection to the practice, but dismissed them on the grounds they were unprofessional.[3]

The next several centuries provided an atmosphere where the lay practitioners tried to set themselves apart from each other as they flourished due to their extraordinary results. The British bonesetter Sir Herbert Barker (d.1950) was knighted for helping humanity.[59]Bonesetters, hereditary physicians, osteopaths and chiropractors became well established in the 1900's, despite organized medicine's feelings against health practitioners outside the medical establishment.[11]

CHIROPRACTIC

Chiropractic was discovered and established in the late 1800's and early 1900's, an era where allopathic medicine was extensively utilizing heroic treatment methods such as leeching, cupping and bleeding.The people of the time were seeking less invasive, more natural healing systems, often with religious foundations involving spiritualism and metaphysical speculations.[48]D.D. Palmer, the discoverer of chiropractic, blended recognized spiritual and metaphysical concepts with the then-current scientific principles, recognizing the relationship between the structure and function of the body. Chiropractic became a form of health care that recognized the body's capacity to heal itself through the nervous system, and examination and treatment methods were developed to assist the nervous system in this process.[12]

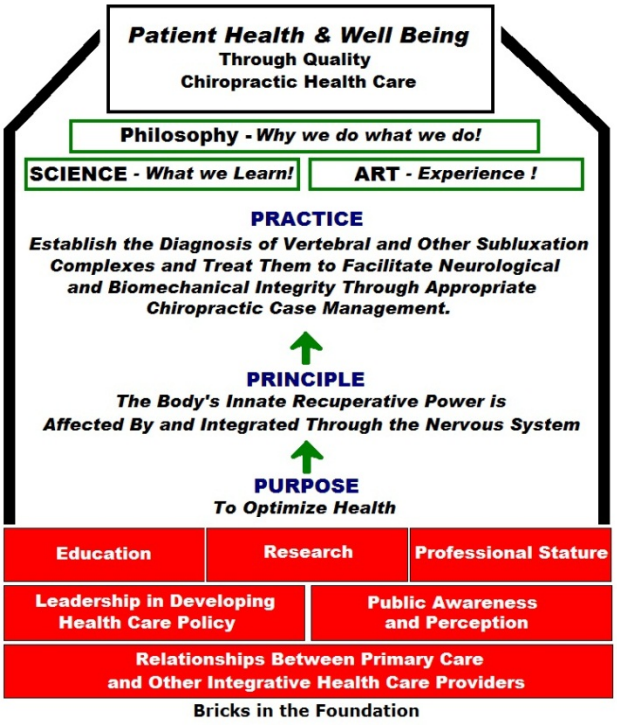


Figure 4

Many critics of chiropractic site its 100 year old philosophy as being a belief system or faith-based health care. Epistemology, the study of knowledge and belief, teaches the relationship between belief and knowledge is that, a belief is knowledge, if the belief is true, and if the believer has a justification (reasonable and necessarily plausible assertions/evidence/guidance) for believing it is true.[57]Yogi Berra said it best when he exclaimed, “It ain’t bragging if it’s true!”Today, not many medical doctors cup and bleed, and likewise, contemporary chiropractors use modern methods of treatment based on the most current science and research available. Although individual doctors of chiropractic may use different components and modalities in their treatment regimes, a common denominator is the use of spinal adjustments to improve and maintain neuro-musculoskeletal function and to support the entire body by influencing the homeostatic mechanisms of the nervous system. He does this by reinforcing constant neural pathways.[5](See Figure 4)

CHIROPRACTIC TERMS

Words have power, and the words used by chiropractors are different, and specific, for a reason. Even the words chiropractic and chiropractor have been incorrectly used in numerous publications dealing with chiropractic manipulative techniques (CMT’s). In many cases, this is not accidental; the authors having had access to original reports that identified the practitioner involved as a non-chiropractor. Although the true incidence of such reporting cannot be determined, it absolutely has adversely affected reader's opinion of chiropractic and chiropractors."[60]

Animal chiropractors diagnose vertebral subluxation complexes (VSC’s), and treat them by performing adjustments. Be it a DC or DVM, when properly trained, they are unique in that they have the knowledge to recognize traditional pathologies so they can integrate their findings and treatment programs with the attending veterinarian.

Vertebral Subluxation Complex

In the first 75 years, the chiropractic lesion was defined predominately in static, structural terms (mal-positioned vertebrae that were less than a luxation) and was called a subluxation.[13,53]The contemporary model, the vertebral subluxation complex, describes a dynamic and complex biomechanical entity with multiple components and associated neurological manifestations.[38](See Figure5)

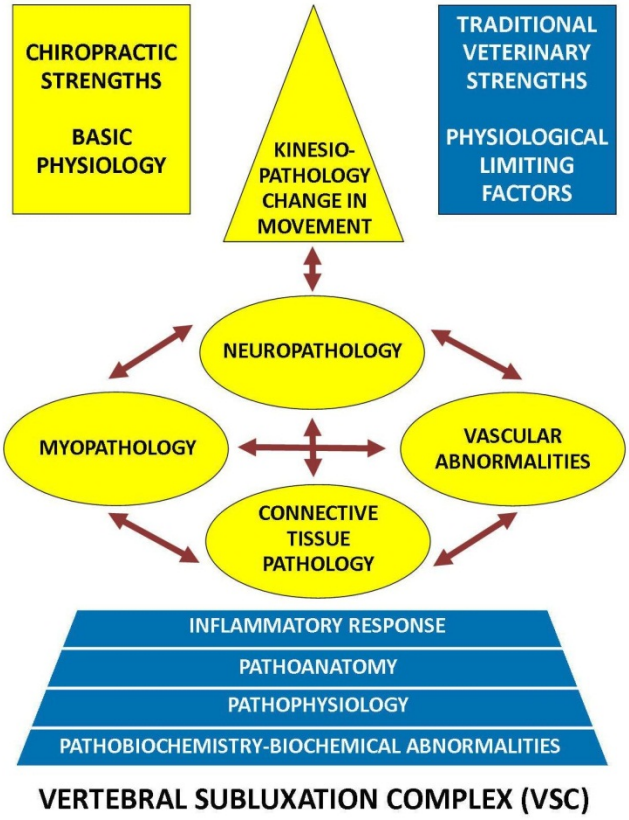


Figure 5

In figure 5, the five yellow elements describe the basic physiology of a motion unit (joint) during mobilization or immobilization. The blue elements describe underlying pathological processes that may hinder the effectiveness of the top five.[20,37,44,68]These pathologies, especially in their advanced stages, are best treated by veterinarians using traditional, allopathic techniques. Chiropractic adjustments best influence the top five elements.

Coordinated variations in movement, neuronal firing, muscle length and activity, blood flow and pressure and collagen fiber propagation is a perfect example of the true biomechanical activities that occur in motion units. The mechanics (movement) of a motion unit is intimately related to the physiological function and health of not only that unit, but up-stream, due to constant neuronal pathway firing, the physiological function and health of the entire animal.[7,20,36,37,44,68]

VSC's are primarily diagnosedusing motion palpation. The entire movement of each vertebral motion unit is examined, with special attention to joint play, active and passive ranges of motion, and most importantly, the consistency of the elastic barrier (end-feel). (See Figure 5)

Adjustment versus Other Forms of Manipulation

Mobilization is a type of passive movement, usually aimed at a 'target' synovial joint, with the aim of achieving increased range of motion or decreased pain. When applied to the spine, it is known as spinal mobilization.[42,43]Manipulation isa manualtherapy technique comprising acontinuum of skilled passive movementsto the joints and/or relatedsoft tissues that areapplied atvarying speeds and amplitudes, includinga [non-specific] small-amplitude/highvelocity [thrust].[2]Although chiropractors may use both of the before-mentioned techniques, their primary treatment tool is the chiropractic adjustment which is unlike any other form of manual therapy.

What makes a chiropractic adjustment unique is its specificity; and that specificity is what is needed to achieve two goals: one, to affect the biomechanics, and two, to change and normalize the afferent neuronal pool. The following are the unique attributes of the adjustment:

- The goal is to treat one vertebral motion unit at a time. That is why a short lever is important. The force of the thrust that is applied is directed through only one motion unit, in a very specific line of correction.
- The thrust is made at the elastic barrier, into the paraphysiological range of motion. (See Figure 6.)
- The thrust is performed to increase the movement of a hypomobile motion unit. This high velocity, low amplitude thrust gaps the facet joints breaking inappropriate collagen bonds[18], activates golgi tendon organs to inhibit muscle spasm, lengthens paraspinal musculature activating muscle spindle cells to induce normal afferent patterning in the constant neural pathways of the core, and inhibits pain by gating nociceptive input by the massive amount of mechanoreceptor input.[7,36]
- The goal is to maintain the health of the nervous system by increasing the frequency of firing (FOF) of the presynaptic pool of neurons.[7,36]

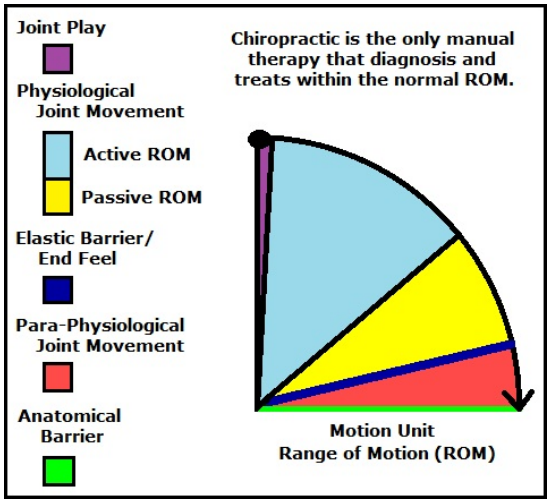
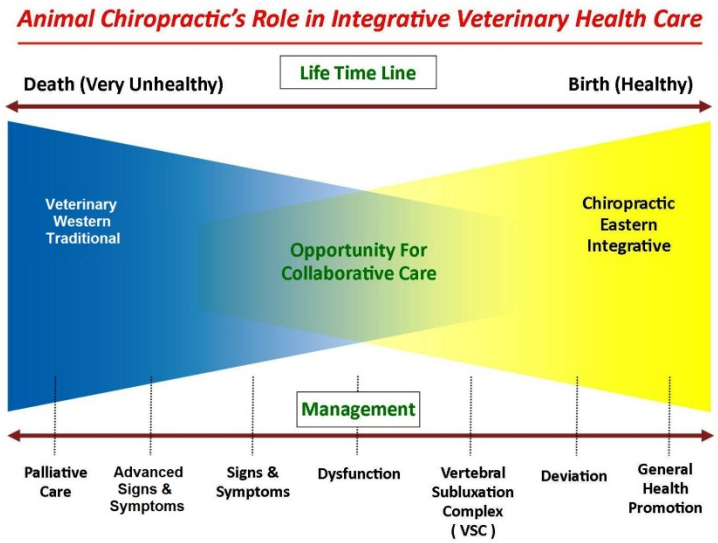


Figure 6

Chiropractic is the only manual therapy that diagnoses and treats motion units within their normal range of motion. This is the key to the long-term potentiation of the chiropractic adjustment, as it not only increases and/or changes mechanics, but also fires tens of thousands of normal afferent pathways, strengthening and supporting up-stream neuronal networks. The only way for the body to reach homeostasis and to maximum its use of its ability to heal itself, is to strengthen these normal pathways.

MANAGEMENT OF THE CHIROPRACTIC PATIENT

Since the goal of the chiropractor is to assist his patient's nervous system in maintaining homeostasis and in the development of positive plasticity, it is imperative for the patient to receive regular examinations as well as make lifestyle changes. Traditionally a client waits to bring a horse to the office until there are advanced signs and symptoms. (Blue in the chart below.)[5]The animal chiropractor works with the others in the health care team, most importantly the attending veterinarian, and together they regularly monitor the horse for suitable diet, appropriate exercise, proper rest and sleep patterns, positive management for emotional stability and good biomechanical health to insure the best neural patterning possible. This will support the body's repair, immune and protective systems in maintaining a better overall level of health; making for a happier and healthier horse, and owner! (Yellow in the chart below.)[5]



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