EXPANDING THE NEUROLOGICAL EXAMINATION USING FUNCTIONAL NEUROLOGIC ASSESSMENT: PART I - METHODOLOGICAL CONSIDERATIONS

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ABSTRACT

Manual assessment of muscular function, in particular a method known as applied kinesiology (AK), is a clinical measure of neurologic function. A review of the literature reveals methodological problems with previous studies of AK as a form of neurologic assessment. Research designs that do not reflect clinical practice and principles of AK are common in the literature. Additional study is warranted to explore the potential of AK manual muscle testing as a diagnostic tool. We outline principles of AK and recommend that future research reflect more accurately the clinical practice of functional neurologic assessment and applied kinesiology.

Keywords: Functional neurology; applied kinesiology; manual muscle testing; physiology; functional medicine; functional illness; neurologic assessment; kinesiology; muscle testing; muscular strength; muscle contraction; skeletal muscle; diagnosis; physical examination

INTRODUCTION

In recent years, a small but interesting group of papers has emerged describing a method of functional neurologic assessment that extends the standard neurological examination by using observed changes in motor function as an indication of patient response to sensory stimuli. The method, known as applied kinesiology (AK), has a thirty year clinical history, and is practiced by clinicians in most of the developed world (ICAK, 1997). Since the preliminary studies of this method show some promise for further development of insights in neurodiagnosis, we present here a review of the literature and a proposed neurologic model for the clinical observations common to the practice of applied kinesiology.

The intent of this paper is to identify potentially fruitful areas for research and clarify potential points of confusion or misinterpretation that would otherwise lead researchers away from productive lines of investigation.

Applied kinesiology is a clinical diagnostic and therapeutic method that draws together elements of complementary medical therapies such as acupuncture, clinical nutrition, and manual manipulation, and combines them with mainstream medical understanding of neurology, biochemistry, and other aspects of physiology. The effect is to create a unified system of functional neurologic assessment, based on known neuroanatomy and physiology, that orchestrates the application of complementary medicine tools into a single working whole.

The clinical basis of the method is the use of manual assessment of muscular function as a means of identifying changes in the central integrative state of alpha motor neurons. These changes are elicited in response to sensory challenges whose impact is mediated through central or peripheral neural mechanisms. Sensory challenges are introduced, changing the central integrative states of central and peripheral neuronal pools, yielding changes in the extent of facilitation or inhibition of motor pathways that are reflected as changes in patterns of facilitation and inhibition of alpha motor neurons. These changes are identified via manual assessment of muscular function.

A muscle that meets the demands of manual muscle testing, giving the appearance of strength, is termed "conditionally facilitated". A muscle that fails to meet the demands of manual testing, giving the appearance of weakness, is termed "conditionally inhibited". Previous studies of manual muscle testing have described these two states as "strong" and "weak" in keeping with the habit of clinicians using applied kinesiology in clinical practice.

Observed changes in patterns of facilitation and inhibition are interpreted according to the known neuroanatomy, and the known value of the sensory challenge in question (i.e., brief stimulation of an acupuncture point or visceral referred pain area). Differences between patient stimulus-response patterns are taken to be reflective of differences in the history of injury, visceral autonomic function, extent and patterning of mechanoreceptor and nociceptor afferents, neuroendocrine function, persistence of patterns of flexor reflex afferent withdrawal, and other functional neurologic changes which are reflected in the plasticity of the neuraxis. Therapeutic measures are chosen according to each patient's observed responses to systematically delivered sensory challenges, allowing clinicians to tailor the treatment process to the specific neurologic state of a given patient.

Part I of this paper reviews the state of research on applied kinesiology (AK). Our analysis of the literature emphasizes an evaluation of the clinical relevance of the studies with respect to the principles and practice of applied kinesiology. Critical evaluation of the quality of the research methodology employed is crucial but is irrelevant to conclusions regarding AK if the process examined relates poorly to the practice of AK.

Much of the research relevant to AK is found in studies of particular methods or interventions, both mainstream and complementary, that have been integrated into AK practice. Many of these methods, including complementary therapies such as acupuncture/meridian system treatment, are supported by a significant body of related research. However, reviews of acupuncture and other components of AK treatment including spinal manipulation, neurologic assessment, nutritional biochemistry and non- applied kinesiology muscle testing are beyond the scope of this article. This review will focus on studies of procedures and outcomes specifically within the context of AK treatment.

We did not evaluate the literature relating to other forms of manual muscle testing because the conclusions are unlikely to apply to AK specific procedures and assessments. This includes a large body of literature relating to non-AK manual muscle testing and mechanically based measurement of muscle strength. The intent of AK manual muscle testing (AK MMT) is to assess the extent to which a muscle is adequately facilitated. This assessment requires significant psychomotor training, and is not the same as testing a muscle for absolute strength, as is more typical in basic orthopedic and neurologic assessment. Fundamental to AK manual muscle testing is the view that the skilled tester can identify differences in test responses that are reflective of differences in patterns of facilitation and inhibition.

No case reports and no outcome studies of any type employing AK treatment were identified in the indexed literature. The preponderance of articles published in the indexed literature relate to evaluation of AK manual muscle testing (AK MMT) as a diagnostic tool. Our search revealed 15 indexed articles relating specifically to AK muscle testing (Friedman and Weisberg, 1981; Grossi, 1981; Haas, Peterson, Hoyer and Ross, 1993; Haas, Peterson, Hoyer and Ross, 1994; Hsieh and Phillips, 1990; Jacobs, 1981; Jacobs, Franks and Gilman. 1984. Kennev. Clemens and Forsythe, 1988; Lawson and Calderon, 1997; Leisman, Shambaugh and Ferentz, 1989; Leisman, Zenhausern, Ferentz, Tefera and Zemeov, 1995; Perot, Meldener and Goubel, 1991; Peterson, 1996; Rybeck and Swenson, 1980; Triano, 1982) and one previous review article (Klinkoski and LeBoeuf, 1990). These AK MMT studies addressed three general issues: comparisons of AK MMT to objective measures of muscle strength or neurologic function, inter- examiner reliability of AK MMT, and changes in AK MMT results related to various experimental stimuli.

SUMMARY OF APPLIED KINESIOLOGY RESEARCH

Three studies have addressed the relationship between AK MMT results and objective neurophysiologic measures of neuromuscular function. These studies have, in general, yielded positive outcomes, demonstrating correlations of AK MMT results with the electrophysiologic measurements. Other studies have compared AK MMT with mechanical measures of isometric strength or attempted to measure changes in AK MMT in response to sensory stimuli. These latter studies suffer from methodological problems that make them less than ideal for evaluating AK as a clinical method. These problems could be corrected in future investigations.

Perot, Meldener and Goubet (1991) compared EMG measurements of the examiner's triceps muscle with the examiner's determination of "inhibited" versus "facilitated" muscle test results. Examiners were found to exhibit less electrical activity, measured by EMG, to counter subject muscle resistance in tests of inhibited muscles compared to facilitated muscles. This suggests an objective basis for the examiner's interpretation of the test outcome.

Somatosensory evoked potentials (SEP) from contralateral median nerve stimulation exhibited differences during AK manual muscle testing of facilitated versus inhibited muscles in fifteen naive subjects (Leisman, Shambaugh and Ferentz, 1989). The authors found no difference between baseline SEP and SEP during tests of a facilitated muscle. They did find significant slowing in SEP during the test of an inhibited muscle.

Leisman, Zenhausern, Ferentz, Tefera and Zemcov (1995) found significant differences in EMG measurements between muscles determined to be facilitated versus inhibited by AK MMT. Leisman and colleagues also found that these differences could not be attributed to fatigue, suggesting for the first time in the literature that failure of a muscle to meet the demands of manual muscle testing might be due to a condition of the muscle or associated neurologic control not associated with fatigue or neuropathy.

Friedman and Weisberg (1981) used manual muscle testing to assess deltoid muscle strength in naive subjects before and after digital pressure over the muscle tested, ingestion of candy, and tasting a vitamin E capsule. Subjects were, blinded to the expected outcomes and examiners were blinded to the subject condition. Between 16 and 20 subjects were rated as being "stronger", "weaker" or "without change" from baseline after each stimulus. They found variations in muscle strength, stronger or weaker than baseline, in many subjects, without a consistent direction across subjects for the various conditions. Repeated testing by multiple examiners or multiple measurements for each subject were not performed and the consistency of the muscle test result for each subject was not determined. These results support the notion that mechanical stimuli (pressure over the muscle to be tested) and stimulation of taste receptors can change MMT results. AK theories do not predict a uniform response across subjects so lack of consistent direction of change is not meaningful in this respect. The level of training of the operator and the test procedures employed are not described so the relevance to recommended AK clinical practices cannot be determined. It is unfortunate that measurements were performed only once.

Grossi (1981) provides an example of a sound research design that is unrelated to AK practice. He attempted to study the effect of an AK procedure involving digital pressure over the belly of the quadriceps on isometric contraction strength. In a well designed placebo-controlled study he found no aggregate difference, no strengthening effect in isometric contraction strength of the quadriceps, in 10 matched pairs of experimental and control subjects. Strength was measured by a force transducer. Unfortunately, he did not employ AK MMT as a measurement tool.

AK MMT results are dependent on examiner sensation of muscle reaction independent of peak isometric force generated (Walther, 1988, pp. 276 - 78). Whether AK MMT results changed in response to this procedure is not known. Furthermore, the technique employed by Grossi is not expected to have an effect in all subjects - particularly if the muscle being evaluated is already considered to have tested "strong" by AK MMT. The technique is reported to have an effect only if certain other AK based signs exist (Walther, 1988, pp. 62-3). Grossi did not measure an outcome that an AK practitioner would expect to change in all patients. The technique is not likely to show any effect in a small sample of 10 healthy subjects, none of whom may be candidates for the procedure according to AK criteria. Though it was reported as an investigation of AK, the results of this study are not relevant to evaluation of AK MMT or other AK procedures.

Changes in tibialis anterior AK MMT results, and neurophysiologic correlation with EMG results in the muscles used by the operators to perform the tests, were later demonstrated following the application of pressure over the belly of the muscle tested (Perot, Meldener and Goubel, 1991). Unlike the previous study of a similar technique (Grossi, 198 1), Perot and his colleagues employed AK MMT and introduced a stimulus into a neurologic context predicted to change the test results based on AK principles.

A study by Nicholas, Melvin and Saraniti (1980) documented changes in mechanical measurements of muscle strength following tactile stimulation of the skin. They did not evaluate AK MMT.

Hsieh and Phillips (1990) studied AK MMT techniques with a computerized dynamometer. The reported intra- and inter-tester reliability coefficients reported were based on force measurements from the hand-held dynamometer under several different testing conditions. The dynamometer readings were not compared to an AK MMT rating of "strong" or "weak". Therefore, the results of this well-designed study are useful for assessing reliability of dynamometer readings but not of AK MMT results. This lack of correlation between AK MMT and mechanical measures of isometric muscle strength has been observed in multiple studies (Grossi, 1981; Kenney, Clemens and Forsythe, 1988; Rybeck and Swenson, 1980).

The most important result from a study by Jacobs (1981) was the ancillary finding of 82 percent interexaminer agreement for AK MMT of the deltoid in 100 healthy volunteers at baseline. The study was designed to detect predictable changes from oral stimulation with various sugar and sesame oil preparations. AK MMT response to any stimulus is dependent on multiple factors unique to each individual, and is not expected to be consistent across multiple subjects. It is not surprising that the researchers observed no consistent "strengthening" or "weakening" effect across subjects for any substance tested. It is noteworthy that changes in AK MMT results were observed for many subjects. A more relevant question to address would be reproducibility of AK MMT findings by several examiners for a particular subject. This study confirms that oral stimulation by nutritional substances does not give predictable AK MMT responses, a fact assumed by practitioners familiar with AK principles but often not recognized by others. Change in AK MMT response to oral stimulation with sugar was also evaluated by Rybeck and Swenson (1980). In a controlled, blinded study of 73 healthy volunteers they found a significant difference in AK MMT of the latissimus dorsi after oral stimulation with sugar or nothing ($p = 0.006$). They found no significant difference between groups using a mechanical measurement of isometric contraction strength of the same muscle. AK theories predict that the latissimus dorsi would be more likely to be influenced by such a stimulus than the deltoid (as used by Friedman, 1981 and Jacobs, 1981). The 84 percent intra-examiner agreement in the control group is similar to the result of Jacobs for agreement between observers. The lack of agreement with mechanical measurements of isometric force is consistent with previously cited studies (Grossi, 1981; Kenney, Clemens and Forsythe, 1988; Rybeck and Swenson, 1980).

Assessment of nutrient status by AK was found to be unreliable for thiamin, zinc, vitamin A and ascorbic acid (Kenney, Clemens and Forsythe, 1988). This double-blind study found intra- and inter-examiner reliability of AK MMT results to be no better than chance on tests of I I subjects. Comparison to objective laboratory measures of nutrient status and dynamometer readings was included and did not correlate with the conclusions from the muscle tests. Researchers employed a single muscle test of the deltoid and utilized diagnostic methods not related to standard AK procedures. The negative results of the study must be interpreted in light of the non-standard procedures employed, the lack of stipulation of the test protocol used, the level of training of the operators, and the small study size.

The lack of consistent response of AK MMT results to oral nutrient stimulation was also noted by Triano (1982). He found that latissimus dorsi AK MMT results changed from "weak" to "strong" with equal frequency using four different nutritional preparations. This contradicts the notion of relationships between specific nutrients and muscles, a belief held by some AK practitioners. This study did not assess the reproducibility of the test results for an individual patient or the possible association between a deficiency of any or all of the tested nutrients and the AK MMT results. The notion that all subjects should respond identically to a given stimulus is false.

A later study by Jacobs, Franks and Gilman (1984) compared diagnosis of thyroid dysfunction (either hypo or hyper function) by clinical evaluation (a standardized history and physical exam), a pre-specified AK MMT protocol, and laboratory tests in 65 patients from ambulatory clinics using a double-blind protocol. They found correlation coefficients of 0.32 ($p < .005$) between AK MMT and laboratory tests and 0.36 ($p < .002$) between AK MMT and clinical evaluation. The correlation between clinical and laboratory evaluations was 0.47 ($p < .000$). This suggests that all three approaches are measuring the same phenomenon. Here an AK MMT protocol performs in a manner comparable to conventional diagnostic methods.

This study of thyroid diagnosis evaluated aggregate results from a protocol of multiple AK MMT assessments rather than a single muscle test finding and used ambulatory patients rather than student volunteers. In practice, AK MMT is used as an adjunct rather than alternative to other diagnostic measures and multiple AK MMTs are performed in a series and parallel fashion (Walther, 1988). Test characteristics for AK MMT will be most clinically relevant when determined in the appropriate clinical context and patient population. This study supports further evaluation of AK MMT as an adjunct to conventional approaches of diagnosis.

A randomized, blinded study of the effect of threatening stimuli on AK MMT results in phobic and control subjects, demonstrated intra- and inter-examiner reliability no better than chance until controlling for confounding variables (Peterson, 1996). A weakening response to concentrating on the phobic stimulus was hypothesized among the phobic subjects. Many control subjects exhibiting the response expected of only the phobic subjects were found to have negative associations with the phobic stimulus during a semi-structured post-test interview. After assessing for such confounding variables determined by the interview, 91 percent of AK MMT results were consistent with valid muscle testing results (a predicted response to the stimulus). This change if findings underscores the difficulties associated with adequate blinding and control in studies of AK MMT and the inherently individual nature of the AK MMT response. This type of design problem creates a bias towards demonstrating no effect of the therapy.

A double-blind placebo control trial using a within-subjects design in 68 native volunteers found that both intra- and inter-examiner agreement on AK muscle test response to a mechanical stimulus were no better than chance alone (Haas, Peterson, Hoyer and Ross, 1993). This study employed a provocative vertebral challenge consisting of pressure to thoracic spinous processes, a procedure used by AK practitioners, and tests of the piriformis muscle. The same researchers also noted no predictable response of AK MMT to high-velocity low-amplitude chiropractic adjustment of the thoracic spine (Haas, Peterson, Hoyer and Ross, 1993,1994). These were rigorously designed and analyzed studies employing experienced muscle testers. The authors acknowledged limitations in using healthy volunteers and lack of additional clinical context for the muscle testers.

A recently published study noted significant interexaminer agreement on AK MMT results that varied according to which muscle was tested (Lawson and Calderon, 1997). Blinded assessment of 32 subject by three examiners, produced excellent interexaminer agreement for tests of the piriformis with kappa ranging from 0.70 to 0.91. Pectoralis major tests showed good reproducibility with kappa from 0.42 to 0.63. Tests of hamstring muscles and tensor fascia lata had marginal agreement with kappa's below 0.4. This blinded study employed AK MMT in a fashion consistent with AK clinical practice. It did not test agreement on response to a provocative stimulus.

Caruso and Leisman (1999) combined measurement of force, time and displacement to create data characterizing the spring constant of muscles being assessed using AK MMT. Both experienced and novice testers were used. Muscles that experienced testers identified as facilitated had spring constant values that were significantly different from muscles identified as inhibited. Spring constant is a measurement of the extent to which an object presents a stiff and unmoving resistance to an applied force.

This finding is consistent with the view in AK that proper performance of MMT requires the clinician to feel for the sensation that the muscle being tested is locking into position against the examiner's testing pressure. The feeling of such a lock is interpreted as a "strong" test result. If the muscle does not lock into position against the examiner's testing pressure, the test result is interpreted as "weak". In this case, the examiner feels a loose or spongy pressure, rather than the stiff resistance of the facilitated test response (Walther, 1988).

Significantly, only examiners with five or more years of clinical experience using AK MMT in practice were able to identify facilitated and inhibited muscles accurately in this study. Examiners with less experience were not able to produce accurate results. This finding suggests that examiners used in studies of AK need extensive experience with the method in order to produce valid results. Results from studies performed with less experienced examiners should be viewed with this in mind.

PRINCIPLES TO CONSIDER WHEN ASSESSING RESEARCH ON APPLIED KINESIOLOGY

Basic Guidelines for Determining Validity of Clinical Research This article is not intended as a general review of criteria for evaluating clinical research. Rather than reiterate a complete list of criteria that may be found elsewhere (Fletcher, Fletcher and Wagner, 1996), we have chosen to focus on issues specific to the study of applied kinesiology. We suggest that methodological rigor alone is not sufficient for adequate study of AK manual muscle testing. Consideration of AK principles such as those outlined in this paper is also necessary in order to produce results relevant to clinical practice.

Heterogeneity of Diagnosis and Treatment

Since AK diagnosis and treatment may consist of elements of many different treatment methods and is geared to individual responses, there is significant variation in the treatment received by patients. The heterogeneity of AK diagnoses, even in patients presenting with a single conventional diagnosis, and the lack of correspondence to conventional diagnoses present particular problems for AK research. For example, it is highly unlikely that any two patients with a diagnosis of migraine headache will receive the same treatment for their condition from an applied kinesiologist. This is in sharp contrast to conventional approaches to care that seek to standardize treatment based on broad diagnostic categories.

This is similar to the problem facing research in several areas of complementary medicine-a lack of correlation between diagnoses deter- mined by conventional means and those of the complementary system. It becomes difficult to compare outcomes and process of care when there is disagreement as to the diagnosis being studied. In epidemiologic terms, there is a potential for trials of complementary therapies to suffer from non- differential misclassification by disease status (from the perspective of the complementary system being studied) leading to a bias in results towards demonstrating no effect of the therapy.

To illustrate this, consider a study of outcomes for pharmacologic treatment of migraine headache. Subjects may be included if they meet certain diagnostic criteria based primarily on self-reported symptoms. They will then be assigned randomly to two or more treatment groups and the overall group responses will be compared for statistically and clinically significant differences in effect. A similar design may be developed to study the effect of manipulation of the cervical spine on migraine headaches with one of the treatment groups receiving a predetermined type and amount of cervical manipulation.

While such a design is a logical extension of past studies on migraine headache to studies of manual medicine, it makes little sense for a study of applied kinesiology. The study subjects are homogeneous with respect to the diagnosis of migraine headache but will be heterogeneous by standards of AK diagnosis. If very few subjects require cervical manipulation by AK standards then any effect observed will be diluted or possibly negated by application of an inappropriate intervention. Conversely, patients found to require cervical manipulation by AK diagnosis may not suffer from headaches. They would not meet the inclusion criteria for a headache study yet could possible benefit from cervical manipulation for relief of other, non-headache symptoms.

An analogous situation exists for all possible diagnoses because AK provides highly individualized assessment. A bias towards the null will exist if heterogeneity of diagnosis and treatment by AK standards is not considered. This will increase the likelihood of negative results.

Applied Kinesiology treatment generally considers multiple causes for each symptom and intervention is typically directed at many factors that may be effecting the symptoms or diagnosis. Patients experiencing migraine headache are evaluated and treated simultaneously for structural, nutritional, and psychological factors that will influence the occurrence of headaches. For example, synergism of effect between altering nutritional intake and spinal manipulation or between meridian system treatment and spinal manipulation will need to be considered in any assessment of AK outcomes. While AK generally employs therapies that have there own basis in research, the essential question for research in AK is to determine the effect of combining these therapies based on particular AK protocols. The effects of combined therapies may be very different from those created by each individual therapy. The large number of possible interventions employed by AK practitioners and potential for numerous positive and negative synergistic effects, makes studying the effect of each component of AK treatment difficult employing traditional outcome methodology and without relevance to the net effect of treatment.

Stipulation Diagnosis and Treatment

As mentioned above, the flexible and individual nature of AK assessment makes it difficult to deliver the same intervention to an experimental group in a manner that makes sense based on standard AK practice. A solution is to study the application of AK protocols that allow the operator latitude in applying AK diagnosis and treatment appropriate for each individual patient. This is analogous to allowing providers freedom within certain guidelines for studies of treatments involving counseling or behavioral interventions. Any study of outcomes for AK will need to give careful consideration to the heterogeneous nature of AK diagnosis and intervention. Treatment effects will be best studied for the system as a whole rather than for individual components of AK. This represents a challenge for AK outcomes research but has relevance to studies attempting to study individual components of AK assessment and treatment as well.

Difficulty with Controls and Blinding

Choice of controls and difficulties with blinding are major challenges to any outcome research on AK. No satisfactory placebo control for applied kinesiology treatment exists. Therefore, outcome studies need to compare AK treatment to existing treatments. Blinding subjects and providers to the treatment received is not possible although blind assessment of outcome could be obtained. Studies of AK MMT are less challenging and can be adequately controlled and blinded.

Choice of Subjects

The performance characteristics of a diagnostic test may vary depending on the population under study. Reproducibility, sensitivity, specificity and related parameters of a test can differ depending on the population chosen for evaluation. This is true for urinalysis and well as chest X-rays and will likely be true for manual muscle testing as well. Studies done primarily on healthy young subjects may not accurately reflect clinical practice. Ideal subjects for studies of AK manual muscle testing should be representative of the population to which one would like to generalize the results. Subjects should also be free of expectations regarding the outcome of the muscle tests under study.

Level of Training of the Testers

The level of training of the operators and standardization of procedures are critical to any objective assessment of AK manual muscle testing. Clinical expertise and experience of the clinicians or muscle testers may influence the study results. Results from experienced practitioners cannot be applied to novice practitioners and vice versa.

Clinical Context and the Systems Nature of AK

The clinical context in which a test is performed changes the test characteristics. Evaluations of AK MMT performed outside of the clinical setting may bear little relation to how well it performs in clinical practice. Operator expectation based on other clinical cues may effect interpretation of AK MMT results. This goes beyond judgment as to facilitated versus inhibited muscle response to the choice of muscle tested and regulation of other variables that may influence the result. In addition to different muscles responding differently from each other, variations in choice and nature of other stimuli applied such as body position, touch, or any other factor affecting neurologic control will influence the outcome.

In the practice of AK, muscle tests are performed multiple times, often under several different conditions. Muscle responses to various stimuli are often evaluated in several muscles with multiple different stimuli - all with knowledge of the patients history, complaints, and other physical findings. The process of AK evaluation reflects much more than a single muscle test result. Indeed, the exact nature of the muscle test may vary from patient to patient. Evaluation of AK MMT as a diagnostic test in isolation from clinical context must be considered in this light. The interwoven nature of AK evaluation make such studies more problematic than studies of other diagnostic maneuvers such as conventional laboratory or physical exam findings.

The Standard Nature and Clinical Relevance of the Procedures

The procedures being studied, as well as the operators involved, should reference standard AK protocols and accepted practice. A study of muscle testing that deviates from AK standards cannot be said to apply to AK practice. The procedures studied should be relevant and appropriate with respect to AK principles, methods and guidelines recognizing that AK is different from other forms of muscle testing employed in both the mainstream and alternative medicine communities. Assessment of muscle strength by mechanical means such as force transducers or by muscle testing as is typically performed in medical settings may not be equivalent to AK manual muscle testing.

In AK theory, response to a particular stimulus is thought to be highly individual. It is a fundamental misunderstanding to assume that a muscle test response to a particular stimulus will be uniform across individuals. While studying intra and interexaminer reliability of AK MMT or consistency across examiners for an individual subject is useful, consistency of response across subjects is not expected. Hypothesizing a uniform response such as "all subjects weaken given stimulus x" is a misinterpretation of AK clinical procedures since each subject is expected to respond individually.

DISCUSSION

The most prominent feature of the status of AK research is the lack of results relevant to clinical practice. Many studies attempting to evaluate this methodologically challenging area have been uninformative because they have proceeded under mistaken assumptions regarding AK practice or focused on questions unrelated to AK clinical procedures. It is surprising that no studies (or even case series) have looked at outcomes of AK care since cost, satisfaction, utilization and changes in symptoms or function are the important results of clinical practice.

Perhaps due to issues of cost and feasibility, researchers have focused instead on small studies of applied kinesiology manual muscle testing. The best evidence available, from studies adhering to AK principles and employing standardized testing by well-trained examiners, supports some degree of intra- and inter-examiner reliability and the existence of an objectively verifiable phenomenon.

It is clear that AK MMT is not the same as measuring isometric muscle strength. Simplistic notions of universal effects of certain stimuli such as "tasting sugar makes one weak" or exact correspondence between single muscle test results and certain pathological states are not valid. Further studies are clearly essential to verify these results and to fully understand the phenomenon of AK MMT and its potential clinical uses. Studies assessing AK MMT as a diagnostic tool should be performed on actual patient populations in an appropriate clinical context to give results applicable to actual practice.

While current research gives no evidence regarding outcomes from treatment with applied kinesiology, it should be noted that AK is an adjunct to existing systems of clinical practice not a replacement (ICAK, 1996). Evidence regarding safety and outcome of AK need to be interpreted in this context. AK diagnosis should complement and not replace standard history taking, physical examination, and diagnostic studies. This should be considered when evaluating the utility of AK and the results of AK studies.

Future studies of AK should focus on outcomes of care including symptoms, function, costs and safety. Only well-designed studies that account for the individual nature of AK diagnosis and treatment and preserve the proper clinical context of AK treatment will be informative. Understanding the individual components of the process of AK treatment remains important. Studies addressing validation of isolated AK procedures need to meet the methodological challenges of studying appropriate subjects in a relevant fashion that reflects the current recognized practice and understanding of AK. Further evaluation of the basic physiologic phenomena involved and correlation of AK manual muscle test results with objective measurements will also advance understanding of this diagnostic and therapeutic system.

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