International Journal of Health Sciences and Research
www.ijhsr.org ISSN: 2249-9571

Review Article

Scientific Reconciliation of the Concepts and Principles of Rood Approach

Kuki Bordoloi[1], Rup Sekhar Deka[2]

[1]PhD Scholar- Srimanta Shankardeva University of Health Sciences, Guwahati, Assam
[2]Associate Professor, Dept of Anatomy, Gauhati Medical College, Srimanta Shankardeva University of Health Sciences, Guwahati, Assam

Corresponding Author: Kuki Bordoloi

ABSTRACT

Rood approach is a neurophysiological approach developed by Margaret Rood in 1940 based on reflex or hierarchical model of the central nervous system. Rood's basic concept was that motor patterns are developed from primitive reflexes through proper sensory stimuli to the appropriate sensory receptors in normal sequential developmental pattern to improve motor performance. Basic principles of Rood approach are normalization of tone, ontogenic developmental sequence, purposeful movement and repetition or practice. Though her theory originated in the 1940s, several revisions underwent before she died, the revision process has still continued till now on the basis of current neuro-scientific evidences. Rood approach has always been a topic of criticism due to the insufficient literature and incomplete background explanations. This paper comprises a brief explanation of the Rood approach and its scientific reconciliation with available literature which shows that many of the basic concepts are still valid and viable within current neuro-scientific thinking.

Key Words: Rood, Neurophysiology, Neurofacilitation, Sensory stimulation, Physiotherapy.

INTRODUCTION

Rood approach is a neurophysiological approach developed by Margaret Rood in 1940. [(1-2)] Rood approach deals with the activation or de-activation of sensory receptors, which is concerned with the interaction of somatic, autonomic and psychic factors and their role in the regulation of motor behavior. [(3-4)]

This neurophysiological approach was designed for the patient with motor control problem. [(5-6)] According to Rood, motor functions and sensory mechanisms are interrelated. The approach is based on reflex/hierarchical model of the central nervous system, where the movement is facilitated or inhibited for rehabilitation purpose. [(7)] Rood's basic assertion was that motor patterns are developed from primitive reflexes through proper sensory stimuli to the appropriate sensory receptors. Rood exploited the normal sequential development to get motor responses and establish proper motor engrams. [(1)]

Rood Approach is one of the several neurophysiology based neuro-facilitation techniques used by rehabilitation specialists, such as the Brunnstrom technique, proprioceptive neuromuscular facilitation, and neurodevelopmental therapy (also known as NDT or Bobath Approach. [(8-10)] Though her theory originated in the 1940s, several revisions underwent before she died. This revision process has continued till now as it still deserves further consideration on the basis of current neuro-scientific evidences. The physiological exploration of Rood's concept was not clearly evaluated in

her time. For example, Rood believed in the ontogenic developmental sequence which is proved to be a flaw in the present time.

Many researchers have suggested that neurophysiological techniques are better than the conventional approaches for patients. [7, 11, 12] However, a research shows that none of the aforementioned neurophysiological approaches prove to be superior to another. [13] It is observed that most of the neurophysiological approaches are always a topic of criticism and Rood is no different. Studies show that though Rood's basis for treatment has been criticized, it can be seen that several of the basic concepts are still valid and viable within current neuroscientific thinking. [7]

PRINCIPLES

Basic principles of Rood Approach are:

1. **Normalization of tone:**
   Using appropriate sensory stimuli for evocating the desired muscular response is the basic principle of Rood approach. [1,14]
2. **Ontogenic developmental sequence:**
   Rood recommended the use of ontogenic developmental sequence. According to Rood, sensory motor control is developmentally based, so that during treatment therapist must assess current level of development and then try to reach next higher levels of control. [14,15]
3. **Purposeful movement:**
   Rood used purposeful activities which can help to get the desired movement pattern from the patient. [14,16,17]
4. **Repetition of movement:**

Rood encouraged to use repetitive movements for motor learning [1, 17]

BASIC CONCEPTS OF ROOD APPROCH

According to Rood, sensory input is required for normalization of tone and evocation of desired muscular responses. Sensory stimulus and their relationship to motor functions play a major role in the analysis of dysfunction and in the application of the treatment. [18]

Rood's four basic concepts are

1. **Mobility and stability muscles(Tonic and phasic)**

According to Rood approach, muscle groups are categorized according to the type of work they do and their responses to specific stimuli. [14,19] Phasic muscles (also known as light work muscles or mobility muscle) are the muscle groups responsible for skilled movement patterns with reciprocal inhibition of antagonist muscles e.g. the flexors and adductors. Tonic muscles (also known as heavy work muscles or stability muscle) are the muscle groups responsible for joint stability with co-contraction of muscles which are antagonists in normal movement.

Though some muscles perform both light and heavy work functions, Rood mentioned specific properties of phasic and tonic muscles. Phasic muscles are fast glycolytic fiber type, superficial and usually one joint muscle. They have high metabolic cost and rapidly fatigue. Tonic muscles are different from phasic. The muscles are slow oxidative fibre type, deep and usually single joint type. These are Pennate, the large area of attachment muscle, has low metabolic cost and slow fatigue. [19]

2. **The Ontogenic Sequence**

Rood introduced two categories of ontogenic sequences

a. **The Motor development sequence**

The motor development sequence finally leads to skilled and finely coordinated movements. The ontogenic motor patterns are:

i. Supine withdrawal
ii. Roll over
iii. Pivot prone
iv. Neck co-contraction.
v. Prone on elbow
vi. Quadruped
vii. Standing
viii. Walking

Rood also categorized these patterns under the following four phases, using the concepts of light and heavy work:

i. **Mobility or reciprocal innervations:** It is a nearly mobility pattern, primarily reflex governed by spinal and supraspinal centers. It includes supine withdrawal, roll over, and pivot prone.
ii. **Stability or co-contraction:** It is defined as simultaneous contractions of antagonists and agonists, working together to stabilize and maintain the posture of the body. It includes pivot prone, neck co-contraction, prone on elbow, quadruped and standing.
iii. **Mobility superimposed on stability:** It is defined as a movement of proximal limb segments with the distal ends of limbs fixed on the base of support. It includes weight shifting in prone on elbows, quadruped, and to and fro rocking that later on can be promoted to crawling in different directions.
iv. **Skill or Distal mobility with proximal stability:** It is defined as skilled work with the emphasis on the movement of distal portions of the body in a finely coordinated pattern that require control from the highest cortical level.

b. The vital functions sequence

The vital functions sequence finally leads to well-articulated speech. The ontogenic patterns are:

i. Inspiration
ii. Expiration
iii. Sucking
iv. Swallowing liquids
v. Phonation
vi. Chewing and swallowing solids
vii. Speech

3. Appropriate sensory stimulation

The relearning of muscular activity is based on the phenomena of summation which activates or deactivates the sensory receptors, utilizing afferent input to affect the anterior horn cell of the spinal cord. [7,20] Rood utilized the anterior horn cell excitability by using sensory stimulus. According to Rood, there are four types of receptors which can be stimulated and in order to get desired muscular response:

i. Proprioceptive receptors
ii. Exteroceptive receptors
iii. Vestibular receptors
iv. Special sense organs

4. Manipulation of the autonomic nervous system

Autonomic nervous system stimulation is also a part of Rood's concept. Different intensity and frequency of the same stimulus determined which system (whether sympathetic or parasympathetic) will be activated. Rood made the point that activation of the sympathetic nervous system is given in case of hypotonic somnolent, whereas parasympathetic nervous system activate is given in hypertonic, hyperkinetic, and hyper excitable patients. Rood recommended that the manipulation of these stimuli can be used in treatment of motor disorder patients. [2]

Rood introduced two groups of autonomic nervous system stimuli:

i. **Sympathetic Nervous System Stimuli:** It includes icing, unpleasant smells or tastes, sharp and short vocal commands, bright flashing lights, fast tempo and arrhythmical music.
ii. **Parasympathetic Nervous System Stimuli:** It includes slow, rhythmical, repetitive rocking, rolling, shaking, stroking the skin over the paravertebral muscles, soft and low voice, neutral warmth, contact on palms of hands, soles of feet, upper lip or abdomen, decreased light, soft music and pleasant odors.

SCIENTIFICALLY RELEVANT COMPONENTS OF ROOD APPROACH

1. Mobility and stability muscle or phasic and tonic Muscles

No muscle can be a purely tonic or phasic muscle. [(21)] According to Garnett et al., motor units could be divided into three classes on the basis of their mechanical properties –(i) type S units are slow, small and fatigue resistant, (ii) type FR units are fast, intermediate in size, and fatigue resistant, and (iii) type FF units are fast, large and fatigable. [(22)] Moreover, Burke et al categorized motor unit types into three classes, slow fatigue resistant (tonic and postural), fast fatigable (phasic and powerful) and fast fatigue resistant (phasic) and the study indicates that all of the muscle fibers in a given motor unit have the same histochemical profile. [(22,23)] Though Rood's classification of muscle activity (based on protection and stabilization) recognized that this is an oversimplification of muscle histochemistry, above researches are similar to its approximation. [(23-25)]

2. Use of sensory stimulation in the recovery of movement and vital activity

Various researchers have found that sensory stimulation is effective for development of skill and movement. [(26-29)] Jarus and Loiter, found that the effect of kinaesthetic stimulation on the acquisition of a lower extremity skill, performance and learning were significant. [(30)]

The sensory stimulation helps in the recovery of movement and vital activities in the following ways:

a) Stimulation of the corticomotor area

Rood used various kind of stimulations including but not limited to kinaesthetic stimulations and stretch. According to Stinear et al., kinesthetic stimulation can excite the corticomotor area primarily at the supraspinal level. [(31)] Day et al. attributed the stretch induced facilitatory effect onto motor evoked potentials in the muscles to the cortical level. [(32)]

b) Stimulation of the anterior horn cell

According to McDonough, sensory stimulation upon the anterior horn cell through circuitry working at a variety of levels through both short and long latency reflex loops, affect the local spinal cord level and the brain. [(33)] Few researches demonstrate sensory feedback with sensory stimulation of muscles can stimulate pathways from the cerebral cortex. This can be done to stimulate single anterior horn cells while the neighbouring anterior horn cells remain depressed. [(34)] Moreover various studies were conducted earlier in order to study the effects of anterior horn cell excitability on the F waves generated in cases of upper and lower limb amputees, spinal cord injuries, ischaemic nerve block, and in rest-induced suppression of healthy subjects. These studies demonstrated that sensory stimulation are effective in exciting anterior horn cells for generating the required F waves which can cause change in motor evoke potential in a variety of patients. [(35-38)]

c) Normalization of tone

Normalization of tone using sensory stimuli is a basic principle of Rood approach. Sensory stimulation can facilitate and inhibit muscle activity which helps in the normalization of muscular tone. According to Linkous et al., tactile stimulation can enhance muscular tone in hypotonic disorder patient. [(39)] Manual skin brushing has an inhibitory effect on H-reflex excitability in normal subjects, which can be used as one of the facilitatory technique for eliciting muscle tone in neurological disorders. [(40)] Stretching has been extensively used in clinical practice, which has abundance benefit in decreasing muscle tone. [(41-50)] Cryotherapy with ice packs and cubes has been suggested to have an antispastic effect by increasing pain threshold and consequently reducing receptor sensitivity of low-threshold afferents. [(51-53)] Researches have suggested that 3 minutes of slow stroking on posterior primary rami can reduce alpha-motoneuron excitability, which can in return, reduce

spasticity. [54-55] Matsumoto et al. showed that F-wave amplitude and F-wave/M-response ratio significantly decreased after 10 minutes of warm heating leading to antispastic effect and also a decrease in gamma-afferent fibre activity. This would lead to a decrease in impulses from the muscle spindles with a consequent inhibition of impulses to the alpha fibres. [56] Various researches reported that effectiveness of vibratory stimuli to spastic muscles, which gives significant improvement in muscle tone and motor recovery. [57,58] Tendon pressure is also used to reduce motoneuron excitability in the central nervous system disorder patient. [59,60] Above researches shown that, Rood's normalization of tone with the use of sensory stimuli is an important part of motor recovery.

3. Use of purposeful movement

Rood's utility of purposeful movement is very common nowadays in rehabilitation practice. Various research works showed that the practice of purposeful movements or activity based movement is an integral part of improving functional status. [61-63] Apache found through activity-based intervention gives significant improvement in both locomotor and object control skills. [64]

4. Use of repetitive movement

Repetition or practice of movement is a basic component of Rood approach. Studies show motor learning employ large amounts of practice. According to Lang et al., repetitions performed during therapy sessions were relatively lower than the numbers of repetitions performed in animal plasticity and human motor learning studies. [65] Studies have shown to reverse the detrimental changes due to a cortical lesion, repetition is essential for learning a motor skill which can alter the cortical representation. [66-68] Hence, it is clear that without repetition, it is difficult to gain motor recovery in motor disorder patients.

5. Manipulation of the autonomic nervous system

According to Metcalfe and Lawes, though autonomic nervous system association with emotion is an old concept, it has a great influence what kind of information is reached to the related circuits governing emotional state in the CNS, and thus on what movement will develop in response. [7] Various studies show that autonomic nervous system manipulation by giving sensory stimulation can cause vital functions activation viz. musical stimuli can influence autonomic responses in an unconscious patient. [69] The autonomic response was characterized by an increase in of vagal response, and contextually, a reduction of heart rate complexity of increasing Formal Complexity and General Dynamic parameters. Various researches also reported that a pleasant and unpleasant odour can alter the cortical and autonomic responses. [70-71] Pleasant odors caused significant decrease in the blood pressure, heart rate, and skin temperature, which indicated a decrease in autonomic arousal. Rocking movements caused a vestibulo-respiratory adaptation leading to an increase in respiration frequency. [73,74] Coloured light can influence the autonomic nervous system which can improve heart rate variability, skin conductance, standard deviations of normalized NN (SDNN)(beat-to-beat) intervals, very low (VLF) and low frequency (LF) levels, decreased heart rate. [75] It has been demonstrated that stimuli such as neutral warmth, contact on palms of hands, soles of feet, upper lip or abdomen can activate the parasympathetic nervous system which supports Rood's concept. [76-78]

6. Improvement in vital activities:

Clinical evidence shows that neurophysiological facilitation can increase ventilation of patients with decreased consciousness which also support Rood's clinical observation. [79-82]

SCIENTIFICALLY OUTDATED

COMPONENTS OF ROOD APPROACH

1. Use of the Ontogenic Sequence

Rood's ontogenetic sequential phases of motor control are not valid based on present developmental studies. According to developmental studies, relearning of movement not occurs from proximal to distal. It always emerges from a sequence of interactions between inherited tendencies and experience dependent learning. [(7,83)] According to Thelen, the developmental changes occur due to the unity of perception, action and cognition, along with the role of exploration and selection in the emergence of new behaviour. [(84)] As per Rood's expectations, the developmental motor sequence was neither followed invariably by developing children nor adhered to by adults when rising from supine to erect posture.

2. Frequency of stimulation of ANS

According to Rood Approach, the low intensity and frequency of stimulation activates the parasympathetic system. The same stimuli at a high frequency and intensity activate the sympathetic system. Metcalfe and Lawes suggested the concept of frequency of the stimulation in manipulation of autonomic nervous system is unnecessary because low-frequency stimulation of a neuron tends to release conventional excitatory amino acid transmitters from small clear vesicles, since high frequency stimulation of the same neuron releases peptides from large, dense-cored vesicles. [(7)]

DISCUSSIONS

Earlier, Rood had theorized based on clinical experience that sensory stimulation can be provided therapeutically to 'wake up' motor responses from the cortex. Herein, purposeful movement, repetition of activity, or practice, plays a part in learning motor skills to reverse the detrimental changes due to a cortical lesion. During application of sensory stimulation, muscles have to be divided into light work (mobility muscle- flexor and adductor) and heavy work (stability muscle- extensors and abductors) as this will help to normalize the muscular tone and motor recovery. Although Rood's stability and mobility muscles are recognized that this is an oversimplification of muscle histochemistry but some scientific evidence supports her concept in present time. Rood suggested that appropriate stimuli are selected based on whether facilitation or inhibition is anticipated and the type of movement that is required. Proprioceptors, exteroceptors vestibular and special sense organ, which receptors are targeted for required motor response activation. Rood's theory is also complemented by the fact that autonomic nervous system stimulation is not only involved in motor activity of vital organs, but also affects the somatosensory system and sensorimotor integration. [(85)] Various researchers have found where ANS stimulation is effective in motor and vital organ stimulation, whereas the frequency and intensity of stimulation is not a valid part of it. Rood's developmental sequence is generally accepted as outdated because developmental studies show that normal human development is not related to different movement pattern. It depends on perception, action, cognition, exploration, inherited tendencies and experience dependent learning. According to Metcalfe, Rood's approach is a modular model approach, which is capable of adapting to advancing knowledge. Hence, therapist can deduct the ontogenic developmental sequence part in the application of Rood's approach. [(7)]

CONCLUSION

Rood's approach is a neurophysiological based approach where relevant physiology is the most important part of this approach – an aspect which was not clearly explored in her time. Though the entire Rood's approach is not used in present time, but some Rood techniques are very common in clinical practice. Current scientific evidence shows Rood's approach

has various valid components which can be justified as valid and viable. A therapist may get more effective results if they use it with physiological base.

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How to cite this article: Bordoloi K, Deka RS. Scientific reconciliation of the concepts and principles of rood approach. Int J Health Sci Res. 2018; 8(9):225-234.

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