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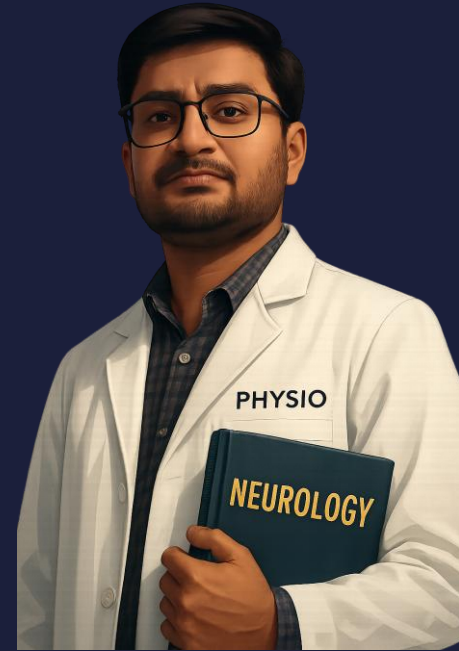
Physiocity



Presents

NEUROPHYSIOTHERAPY TECHNIQUES

Approaches to Neurological Rehabilitation



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What This Presentation Covers

01



Foundations

Historical context & the hierarchical model of motor control

02



NDT / Bobath Concept

Origins, principles, handling techniques, evidence

03



Proprioceptive Neuromuscular Facilitation

Diagonal patterns, techniques, evidence

04



Brunnstrom Movement Therapy

Recovery stages, synergies, evidence

05



Rood Approach

Sensory facilitation & inhibition, evidence

06



Synthesis

Comparative evidence & modern clinical practice



The Neurophysiological / Facilitation Approaches

Between the 1940s and 1960s, a family of treatment philosophies emerged to rehabilitate patients with poliomyelitis, cerebral palsy, and stroke. Each was built by a clinician-scientist pair who combined bedside observation with the neurophysiology of their era — chiefly the work of Sherrington, Jackson, and Magnus on reflexes and postural control.

1943–48

Berta & Karel Bobath

London, UK

1946–52

**Herman Kabat, Margaret
Knott, Dorothy Voss**

Kaiser-Kabat Institute, USA

1960s

Signe Brunnstrom

USA (Swedish-born PT)

1950s

Margaret Rood

USA



From the Hierarchical Model to Systems Control

The Hierarchical Model

- Rooted in the work of Hughlings Jackson, Sherrington, and Magnus
- Higher cortical centres are assumed to progressively inhibit lower brainstem/spinal reflex centres
- CNS lesions → “release” of primitive reflexes and abnormal tone
- All four classical approaches (NDT, PNF, Brunnstrom, Rood) were built on this model

The Modern Systems / Task-Oriented Model

- Influenced by Bernstein's motor-control theory and dynamic-systems thinking
- Movement emerges from interaction of the individual, task, and environment — not a fixed cortical hierarchy
- Emphasises motor learning, repetition, task-specific practice, and active problem-solving
- Underpins current best-evidence practice (see Synthesis, slides 34–37)

SECTION 02

NDT / Bobath Concept

Neurodevelopmental Treatment — the most widely used facilitation approach in Western stroke rehabilitation



Founders & Historical Development

Berta Bobath, a German-born physiotherapist, and her husband Dr Karel Bobath, a neuropsychiatrist, arrived in London as refugees and began developing their approach around 1943 while working with children with cerebral palsy. They formally described the technique in 1948 and opened their treatment centre in 1951.

The couple later took their postgraduate courses to the United States, where the method became known as Neuro-Developmental Treatment (NDT). Berta authored *Abnormal Postural Reflex Activity Caused by Brain Lesions* in 1965, cementing the theoretical framework for clinicians worldwide.



Key Figures

- Berta Bobath — physiotherapist, developed handling techniques
- Karel Bobath — neuropsychiatrist, provided neurophysiological rationale
- 1943–48 — concept developed, London
- 1951 — Western Cerebral Palsy Centre opened
- 1965 — Berta Bobath's key text published



Theoretical Basis & Postural Reflex Mechanisms

The original Bobath framework rested on the hierarchical model: a CNS lesion releases abnormal tone and primitive reflex patterns that were previously suppressed by higher centres. Treatment therefore aimed to inhibit abnormal tone/reflexes and facilitate more “normal” movement and postural reactions.



Postural Reflex Mechanisms

Normal postural tone, reciprocal innervation, and patterns of coordination (righting & equilibrium reactions) underlie skilled movement.



Abnormal Tone

Spasticity, rigidity, and flaccidity disrupt the postural mechanism and produce stereotyped, mass movement patterns.



Evolving Concept (post-1990s)

Later revisions incorporated motor learning and systems theory, reframing treatment around task-specific active practice.



Core Treatment Principles



Individualised, problem-solving approach

Ongoing assessment of movement quality guides continuously adapted handling — not a fixed exercise protocol.



Key points of control

Therapist's hands guide movement at proximal/distal points (shoulder, pelvis, hand) to influence tone and alignment.



Inhibition of abnormal tone

Reflex-inhibiting postures and gentle handling reduce spasticity or hypotonicity before movement is facilitated.



Facilitation of normal movement & postural control

Once tone is normalised, guided active movement and weight-shifting encourage more typical motor patterns.



24-hour, whole-team management

Positioning, handling, and carry-over are extended by family and multidisciplinary team throughout the day.



Handling Techniques in Practice

Reflex-Inhibiting Patterns (RIPs)

Positioning limbs/trunk opposite to the dominant spastic pattern to reduce tone — e.g. trunk rotation and shoulder protraction to lower extensor spasticity.

Key Points of Control

Central (trunk/shoulder/pelvic girdle) or distal (hand/foot) contact points used by the therapist to guide alignment and grade postural tone.

Facilitation of Righting & Equilibrium

Weight-shifting, tilting, and perturbation activities used to re-train automatic balance reactions in sitting/standing.

Graded Sensory & Proprioceptive Input

Weight-bearing through an affected limb and tactile cues are used to “normalise” sensory feedback and tone.



Clinical Populations & Goals



Cerebral Palsy

- Original population for which the concept was designed
- Aims: normalise tone, prevent contracture, enable functional postural control for daily activity
- Delivered through play-based, family-integrated handling



Adult Hemiplegia (Stroke)

- The dominant application in Western adult neuro-rehabilitation
- Aims: reduce spasticity, restore symmetrical posture/weight-bearing, retrain trunk & limb control for ADLs and gait
- Typically integrated with task practice in modern therapy



What the Systematic Reviews Show

Kollen et al., Stroke (2009) — Systematic Review of RCTs

Searching MEDLINE and CENTRAL, this landmark review found no evidence that the Bobath concept was superior to other approaches across sensorimotor control, dexterity, mobility, or activities of daily living. Best-evidence synthesis showed only limited support for balance-control outcomes such as symmetry of weight distribution.

Luke et al. (2004) — RCT Comparison with PNF

Bobath therapy showed a large advantage over PNF specifically for standing-balance outcomes, but the two approaches did not differ on any other measure — and Bobath did not out-perform other interventions on strength or coordination.



Later Reviews & Quick-Recall Summary

Cumulative Evidence (2018–2021)

- Diaz-Arribas et al. (2018 SR): Bobath is not superior for mobility, lower-limb control, gait, balance, or ADLs; moderate evidence favours forced-use/CIMT for upper-limb control
- Pathak et al. (2021, PROSPERO-registered SR): confirmed no strong documentation of superiority over other neuro-physiotherapy techniques

Quick Recall — “B.O.B.A.T.H.”

- B** Bilateral, whole-body handling
- O** Ongoing assessment (problem-solving, not fixed protocol)
- B** Balance / postural reactions facilitated
- A** Abnormal tone inhibited first
- T** Task-oriented carry-over (modern revisions)
- H** Hands-on key points of control

SECTION 03

Proprioceptive Neuromuscular Facilitation

PNF — diagonal, resistance-based patterns built on Sherrington's neurophysiology



Founders & Historical Development

Dr Herman Kabat, a neurophysiologist, began developing “proprioceptive facilitation” in the early 1940s, drawing on the stretching/resistance work of Australian nurse Sister Elizabeth Kenny with poliomyelitis patients, and grounding it in Sir Charles Sherrington's neurophysiology of irradiation, reciprocal innervation, and successive induction.

Physiotherapist Margaret “Maggie” Knott joined Kabat in 1945, and Dorothy Voss joined in 1952. Voss added the term “neuromuscular” in 1954, giving the technique its current name. Knott and Voss authored the first PNF textbook in 1956.



Timeline

- Early 1940s — Kabat: “proprioceptive facilitation”
- 1945/46 — Kaiser–Kabat Institute founded with Knott
- 1952 — Dorothy Voss joins the team
- 1954 — term “neuromuscular” added by Voss
- 1956 — first PNF textbook (Knott & Voss)



Neurophysiological Basis & Basic Procedures

Neurophysiological Principles

Irradiation

Spread of excitation from strong muscle groups to weaker synergists (Sherrington).

Reciprocal Innervation

Contraction of agonists coupled with relaxation of antagonists.

Successive Induction

Contraction of an antagonist facilitates a subsequent stronger contraction of its opposite.

Basic Manual Procedures

- Manual contact — lumbrical grip guiding the direction of movement
- Maximal resistance — graded to the patient's ability, enhancing irradiation
- Stretch stimulus — quick stretch at end-range facilitates contraction
- Traction & approximation — joint distraction facilitates movement; compression facilitates stability
- Timing — normal distal-to-proximal sequencing, or “timing for emphasis” on weak components
- Verbal & visual cues — commands and eye tracking reinforce the desired pattern



Diagonal Movement Patterns (D1 / D2)

PNF replaces single-plane exercise with spiral, diagonal patterns that mirror functional movement, combining flexion/extension with rotation and abduction/adduction across each joint. Each extremity has two diagonals (D1 and D2), each with a flexion and an extension component.

Extremity	Diagonal 1 (D1)	Diagonal 2 (D2)
Upper Limb	Flexion–adduction–external rotation ↔ Extension–abduction–internal rotation	Flexion–abduction–external rotation ↔ Extension–adduction–internal rotation
Lower Limb	Flexion–adduction–external rotation ↔ Extension–abduction–internal rotation	Flexion–abduction–internal rotation ↔ Extension–adduction–external rotation

Each pattern combines a rotational component with the primary motion — emphasising the spiral, diagonal character of normal functional movement.



Specific Facilitation Techniques

Rhythmic Initiation

Progresses passive → active-assisted → resisted movement to teach a pattern and reduce rigidity.

Repeated Contraction

Repeated isotonic contractions with quick stretch at the point of weakness reinforce a specific pattern.

Slow Reversal

Alternating resisted concentric contractions of agonist and antagonist promote reciprocal coordination.

Rhythmic Stabilisation

Alternating isometric contractions of opposing muscle groups build co-contraction and stability.

Hold–Relax

Isometric contraction of the tight (antagonist) muscle followed by relaxation, used chiefly to increase range of motion.

Contract–Relax

Isotonic contraction of the restricting muscle into resistance, followed by relaxation, then movement into new range.



What the Trials & Reviews Show

46 RCTs

ROM systematic review (2018)

Across 1,864 healthy adults, assisted hold-relax and contract-relax techniques increased range of motion versus control, though certainty was rated low to very low.

SMD -1.14

Knee OA meta-analysis (2025)

PNF produced significantly greater pain reduction and active knee ROM gains than control across 5 RCTs (n=201), though the pain effect did not reach the minimal clinically important difference.

SMD -1.40

Bobath vs PNF, balance

In head-to-head RCT comparison, Bobath therapy showed a large advantage over PNF for standing balance specifically — other outcomes did not differ.



PNF — QUICK RECALL

Memory Aid: “S.T.R.E.T.C.H.”

S

Stretch reflex — quick stretch triggers facilitation

T

Traction / approximation — joint distraction & compression

R

Resistance — maximal, graded resistance enhances irradiation

E

Emphasis on diagonal, spiral patterns (D1/D2)

T

Timing — normal distal-to-proximal sequence, or timing for emphasis

C

Contact — manual (lumbrical) grip guides direction

H

Hold-relax / contract-relax — core techniques for ROM and strength

SECTION 04

Brunnstrom Movement Therapy

Using synergies and reflexes as stepping-stones toward voluntary, isolated movement



Founder & Theoretical Basis

Signe Brunnstrom, a Swedish-born physical therapist working in the United States, developed her approach to hemiplegia in the 1960s after years of clinical observation of stroke patients' recovery patterns.

Recapitulation of Ontogeny

Motor recovery after stroke is assumed to mirror normal infant motor development, moving from reflexive to voluntary control.

Reflexes as a Resource

Rather than being purely suppressed, primitive reflexes and mass synergy patterns are deliberately used as an early stage on the way to voluntary, selective movement.

Sequential Stage-Based Recovery

Recovery is described as a predictable sequence through seven stages, from flaccidity to full voluntary isolated control.



The Seven Stages of Motor Recovery

I	Flaccidity	No voluntary movement; muscles flaccid
II	Synergy emerges	Minimal voluntary movement; spasticity begins
III	Synergy voluntary	Spasticity peaks; synergy patterns performed voluntarily
IV	Movement out of synergy begins	Spasticity starts to decline; some movement combinations independent of synergy
V	Independence from synergy grows	Spasticity continues to decline; more complex combinations achieved
VI	Isolated joint movement	Spasticity nearly disappears; coordination approaches normal
VII	Normal function returns	Full voluntary control restored



Limb Synergies & Treatment Techniques

Upper-Limb Synergy Components

	Flexor Synergy	Extensor Synergy
Shoulder	Retraction, elevation, abduction, ext. rotation	Adduction, internal rotation
Elbow	Flexion	Extension
Forearm	Supination	Pronation

Treatment Techniques by Stage

- Flaccid stage: reflexive & sensory stimulation (stroking, stretch) to elicit the first response
- Synergy stage: synergy patterns are facilitated, then used voluntarily by the patient
- Later stages: movement is deliberately trained out of synergy toward isolated, functional patterns
- Associated reactions and proprioceptive/exteroceptive stimuli (e.g. resistance, tapping) are used purposefully to trigger movement



Clinical Application & the BRS Outcome Measure

Brunnstrom staging remains in everyday clinical use — less now as a stand-alone treatment programme, and more as the Brunnstrom Recovery Stage (BRS), a widely used clinical descriptor of a stroke patient's stage of motor recovery for arm, hand, and leg (scored separately, level I–VII).

As an Assessment Tool

BRS is scored for arm, hand, and lower-limb separately and is frequently reported alongside the Fugl-Meyer Assessment in stroke research and practice.

As a Treatment Guide

Modern practice often blends Brunnstrom staging with task-specific and motor-relearning techniques rather than using synergy-based facilitation alone.



What the Trials Show

Pandian, Arya & Davidson (2008) — Comparative RCT

This trial compared Brunnstrom Movement Therapy with the Motor Relearning Programme in stroke rehabilitation, contributing to a broader literature in which neither synergy-based nor task-oriented approaches show consistent, clear superiority for every outcome domain.

Randomised Trial on Chronic Post-Stroke Hand Rehabilitation

In a trial of 30 chronic stroke patients comparing Brunnstrom hand-manipulation protocols with a Motor Relearning Programme (outcomes: BRS-Hand, Fugl-Meyer Wrist/Hand), both approaches produced measurable gains — underscoring that evidence for the comparative superiority of any single named approach remains limited overall.



BRUNNSTROM — QUICK RECALL

Memory Aid: the “Seven F's”

I	Floppy	Flaccid, no movement
II	Flicker	First minimal voluntary movement; spasticity appears
III	Flex hard	Spasticity peaks; synergy performed voluntarily
IV	Fading	Spasticity declining; some out-of-synergy movement
V	Free-ing up	Complex combinations independent of synergy
VI	Fine control	Spasticity nearly gone; near-normal coordination
VII	Full recovery	Normal voluntary movement restored

SECTION 05

The Rood Approach

Using controlled sensory stimulation to normalise tone and guide motor output



Founder & Theoretical Basis

Margaret Rood, an American occupational and physical therapist, developed her sensorimotor approach from the 1940s–50s. It was among the earliest neurophysiological approaches to make cutaneous and proprioceptive sensory stimulation — not manual resistance or reflex-inhibiting posture — the primary tool for shaping motor output.

Sensory Control of Motor Output

Specific, graded sensory stimuli evoke desired reflexive muscular responses, which are then reinforced into voluntary patterns.

Ontogenetic Developmental Sequence

Treatment progresses through developmental postures (e.g. prone, supine, crawling, kneeling, standing) from reflexive to skilled control.

Purposeful, Repeated Activity

Motor responses are elicited within a goal-directed activity and repeated to support motor learning, rather than isolated exercise.



ROOD — FACILITATION

Techniques to Increase Tone / Activity



Fast brushing

Battery-powered brush applied briefly over the skin/dermatome of a muscle to increase its excitability.



Quick icing

Brief application of ice (3–5 seconds) provides a fast, potent facilitatory stimulus.



Tapping

Light manual tapping over the muscle belly or tendon stimulates the muscle spindle via the monosynaptic stretch reflex.



Quick stretch

A fast stretch to the muscle activates the myotatic (stretch) reflex, producing reflexive contraction.



Joint compression / approximation

Heavy joint compression (through body weight) facilitates co-contraction and postural extensor activity.



ROOD — INHIBITION & SEQUENCE

Inhibitory Techniques & the Developmental Sequence

Techniques to Decrease Tone

- Slow, rhythmic stroking along paravertebral spinal extensors — generalised calming
- Neutral warmth — wrapping the limb/body to reduce sympathetic arousal and tone
- Prolonged/maintained stretch — sustained muscle lengthening inhibits the stretch reflex
- Slow, maintained joint compression through long bones — promotes relaxation
- Slow rolling (side to side) — reduces generalised hypertonicity

Ontogenetic Developmental Sequence

- 1 Supine withdrawal
- 2 Roll
- 3 Prone on elbows / Pivot prone
- 4 Co-contraction (neck, quadruped)
- 5 Weight-bearing (quadruped, kneeling)
- 6 Skill (standing, walking)



Clinical Populations & Uses Today

Few clinicians apply Rood's original system in full, but many of its individual techniques remain in routine use — often blended with other neurophysiological or task-oriented methods.



Disorders of Consciousness & Low Tone

Light tapping, icing, and auditory stimulation used to enhance arousal and facilitate initial motor responses (e.g. after severe brain injury).



Cerebral Palsy & Paediatric Hypotonia

Facilitation techniques and developmental-sequence positioning used to build postural tone and antigravity control.



Stroke & Peripheral Neuropathies

Combined with conventional physiotherapy for tone normalisation, sensory re-education, and functional independence in ADLs.



What the Literature Shows

Bordoloi & Deka, Int J Health Sci Res (2018) — Scientific Reconciliation

This review notes that Rood's approach has faced longstanding criticism over sparse original documentation, but concludes that many of its basic sensory-facilitation concepts remain valid and viable when reconciled with current neurophysiological understanding.

Modified Rood's Approach in Haemorrhagic Stroke, Assam, India — Clinical Trial

Patients receiving a home-exercise programme plus Rood-based facilitation and inhibition techniques showed significantly greater improvement in Barthel Index self-care scores after 3 months than conventional physiotherapy alone — supporting Rood's techniques as a useful adjunct rather than a stand-alone protocol.



ROOD — QUICK RECALL

Memory Aid: Facilitate = “B.I.T.S.”, Inhibit = “S.N.J.S.”

Facilitate — B.I.T.S.

- B** Brushing (fast)
- I** Icing (quick)
- T** Tapping over muscle/tendon
- S** Stretch (quick) & joint compression

Inhibit — S.N.J.S.

- S** Slow stroking (paravertebral)
- N** Neutral warmth
- J** Joint compression (slow/sustained)
- S** Sustained stretch



Comparing the Four Approaches — Theory

Approach	Founders / Era	Core Theoretical Idea
NDT / Bobath	Bobaths, 1943–48	Inhibit abnormal tone via handling; facilitate normal postural reactions
PNF	Kabat, Knott, Voss, 1940s–50s	Resistance & stretch on diagonal patterns drive irradiation and reciprocal innervation
Brunnstrom	Brunnstrom, 1960s	Recovery recapitulates development; reflexes/synergies used as a bridge to voluntary control
Rood	Rood, 1950s	Graded sensory (cutaneous/proprioceptive) stimulation drives reflexive, then voluntary, motor output



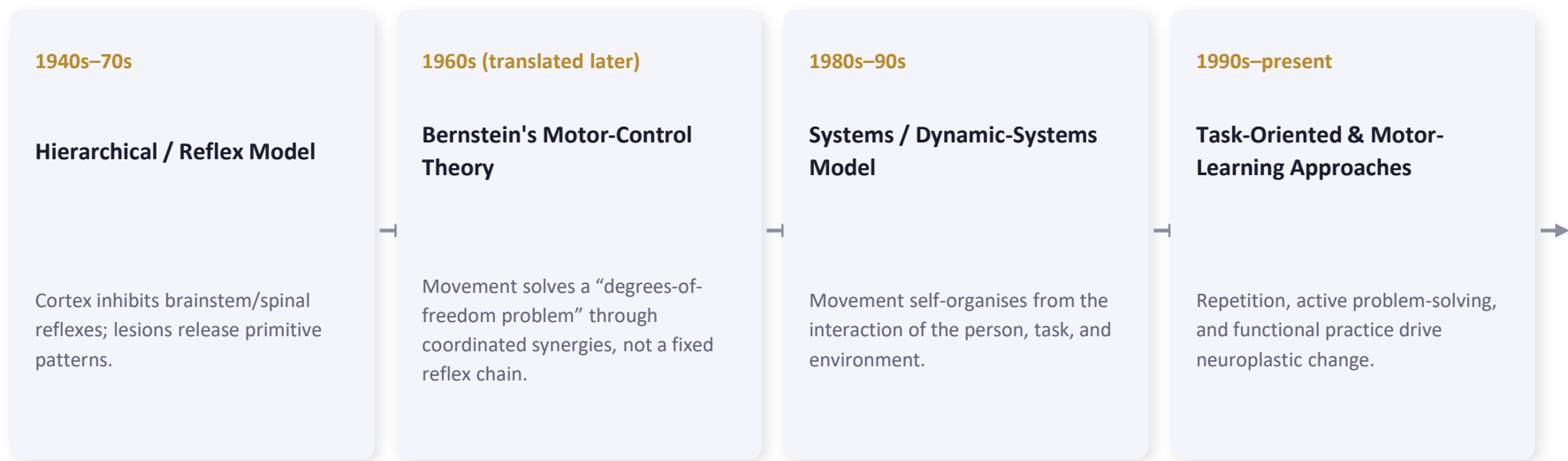
Comparing the Four Approaches — Technique

Approach	Primary Tool	Signature Techniques
NDT / Bobath	Manual handling	Key points of control, reflex-inhibiting patterns, weight-shift facilitation
PNF	Resistance + stretch	Diagonal D1/D2 patterns, hold-relax, contract-relax, rhythmic stabilisation
Brunnstrom	Reflex/synergy use	Staged use of mass flexor/extensor synergies, associated reactions
Rood	Sensory stimulation	Fast brushing, icing, tapping (facilitate); slow stroking, neutral warmth (inhibit)



The Paradigm Shift in Motor-Control Theory

All four classical approaches share a common ancestor: the hierarchical, reflex-based model of motor control from the early-to-mid 20th century. From the 1980s onward, this model was progressively challenged.





Cochrane Review 2025: Physical Rehabilitation After Stroke

Todhunter-Brown et al. (Cochrane Database of Systematic Reviews, 2025) is the most current, highest-level synthesis comparing categories of physical rehabilitation — including the “neurophysiological” treatment components that NDT, PNF, Brunnstrom, and Rood represent — against other approaches after stroke.



Functional Task Training

May be the most useful category of intervention overall for recovery of function and mobility after stroke.



Neurophysiological Approaches

May be no more effective than — or less effective than — other rehabilitation approaches for instrumental ADLs; low-certainty evidence.



Certainty of Evidence

Limited by substantial heterogeneity, mostly small trials, and differing populations/interventions across studies.



SYNTHESIS

Clinical Decision-Making in Current Practice



Eclectic, evidence-informed selection

Most clinicians blend elements of several approaches rather than adhering strictly to one named school of thought.



Prioritise task-specific, repetitive practice

Best-current-evidence supports functional task training as at least as effective as — often more effective than — neurophysiological facilitation alone.



Retain useful individual techniques

Specific tools (e.g. PNF stretching for ROM, Rood's tapping/icing for arousal, Bobath handling for alignment) still have a legitimate, targeted role.



Use staging/outcome tools independent of the treatment package

Brunnstrom Recovery Stage and similar scales remain valuable for assessment and communication even where synergy-based treatment itself is not used.



Base practice on guidelines, not tradition alone

Kollen et al. (2009) and later reviews all converge on the same message: evidence-based guidelines, not therapist preference, should drive approach selection.

KEY TAKEAWAYS

One Line Per Approach

● **NDT / Bobath**

Inhibit abnormal tone through handling, then facilitate normal postural reactions — widely used, but not proven superior to other approaches.

● **PNF**

Diagonal, resistance-based patterns exploiting irradiation and reciprocal innervation — solid evidence specifically for range-of-motion gains.

● **Brunnstrom**

Uses reflexes/synergies as a bridge through seven recovery stages — the staging scale (BRS) remains valuable even where the treatment method has waned.

● **Rood**

Graded sensory stimulation shapes reflexive, then voluntary, motor output — individual techniques persist as useful adjuncts.

Overarching principle: functional, task-specific, repetitive practice consistently rivals or outperforms any single facilitation approach used alone.



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